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THE *CHILDREN'S APPERCEPTION TEST* WITH CEREBRAL PALSIED AND NORMAL CHILDREN[1]

RAYMOND H. HOLDEN

At present there is fairly general agreement about some cognitive aspects of cerebral palsy (5, 6, 11). But a survey of the literature reveals little evidence of exploration of conative aspects of personality (3, 8). Besides a few reports of paper-and-pencil personality inventories (10, 12), there are only two notable studies, Klapper and Werner's (9) cerebral palsied twin study characterized by excellent methodology, and Werner's Rorschach study of brain-injured children (13) which emphasizes qualitative differences between the experimental and non-brain-injured control group.

In an attempt at an initial exploration of the personality of school-aged cerebral palsied children, the Children's Apperception Test (hereafter referred to as CAT) was selected as a projective instrument. The purpose of this study is to evaluate the effectiveness of the CAT as a projective test with cerebral palsied children.

The CAT was devised by Bellak (2) for children aged 3 to 10 years of age. The test consists of 10 pictures depicting animals in various situations. Table 1, Column 2, briefly describes the content of each picture card. The CAT is a descendant of Murray's Thematic Apperception Test, which Bellak (2) feels is unsuitable for young children. The basic assumption of the CAT is that it is an apperceptive method: "a method of investigating personality by studying the dynamic meaningfulness of the individual defferences in perception of standard stimuli" (2, p. 1). The CAT is said to be "able to reveal the dynamics of interpersonal relationships, of drive constellations and the nature of the defenses against them" (2, p. 2). It is hoped that the results of this study will shed some light on the generality of these statements as they apply to brain-injured (cerebral palsied) children.

PROCEDURE

Subjects. Eight cerebral palsied children (five boys, three girls) attending the Meeting Street School Cerebral Palsy Center, Providence, Rhode Island, composed the experimental group. The chronological age of these children ranged from 5 years, 7 months, to 12 years, 11 months, with an average of 9 years, 10 months. Their average mental age was 7 years, no months, and their average IQ was 73.1, only slightly lower than previously

[1] This paper was presented at the first Scientific Session of the Rhode Island Psychological Association, Providence, October, 1954.

reported mean IQs for large cerebral palsied populations (8). Seven of the eight children had IQs between 60 and 80, and one child's IQ was 116.

Seven normal school children and three children with behavior problems constituted the control group. The results were pooled because inspection of the data revealed no noticeable differences in the variables under consideration. The finding of no observable differences between stories given by normal and neurotic adult subjects on the TAT, for example, has already been reported in the literature (1). The seven "normals" were five boys and two girls from the Walter J. Paton Elementary School in Shrewsbury, Massachusetts, and the three "neurotic" children were two boys and a girl from the Emma Pendleton Bradley Home, Riverside, Rhode Island, an inpatient hospital for disturbed children. The average chronological age of the control group was 7 years, 3 months (range: 6 years, 2 months, to 7 years, 8 months). The average mental age was 7 years, 5 months (range: 5 years, 10 months, to 8 years, 2 months), and their average IQ was 101.5 (range: 92 to 115).

It can be seen that the experimental and control groups are most nearly equated for mental age. Thus the cerebral palsied children, although having had longer experience in the world, are nearly equal to the control group in level of mental ability, although not equal in the rate of mental growth (as evidenced by the widely discrepant average IQs).

The CAT was administered individually by the author according to standard administration procedure described by Bellak (2). It was the author's qualitative impression that motivation and interest of subjects in

TABLE 1

ANALYSIS OF CAT STORIES BY CARDS

Card	*Most Common Description*	Cerebral Palsy *Description*	Cerebral Palsy *Thema*	Control *Description*	Control *Thema*
I	Chickens eating	100%	0%	30%	70%
II	Bears pulling on rope	75%	25%	10%	90%
III	Lion sitting on chair	50%	50%	30%	70%
IV	Kangaroo (or other animal) on bicycle	50%	50%	20%	80%
V	Bears(s) sleeping	50%	50%	50%	50%
VI	Bears sleeping	87%	13%	30%	70%
VII	Lion (tiger) chasing monkey	62%	38%	40%	60%
VIII	Four monkeys (gorillas) eating (talking)	62%	38%	20%	80%
IX	Rabbit in bed	38%	62%	20%	80%
X	Two dogs in bathroom (spanking)	38%	62%	30%	70%
	Average Per Cent Descriptions	61%		28%	
	Average Per Cent Thema		39%		72%

both groups were high. All children responded with apparent pleasure to the pictures, and no card was ever refused by any child.

Analysis of data. Test data were analyzed in two ways: (1) the percentage of card description without story content (Table 1); and (2) the number of descriptions per subject in both the cerebral palsied and control groups (Table 2).

TABLE 2

ANALYSIS OF CAT DESCRIPTIONS BY SUBJECTS

Group	Number of Descriptions										
Subject:	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*Average*
Cerebral Palsy	7	9	5	5	1	8	7	6	–	–	6.0
Control	2	0	8	6	2	0	0	2	8	0	2.8

The classification of CAT stories as description or thema was a fairly easy one. All stories were considered as "description" that contained only the elements found in the most common description of each card with no story added. A "thema" is defined as any description of the card, *plus* the verbalization of additional story material, feeling, tone, affect, or ending to the story which could be interpreted according to some personality theory.

A test of reliability of classifying the stories was done. A random sample of 50 per cent of the records was classified independently by another psychologist. Eighty-five per cent agreement was obtained on cerebral palsied stories, and 93 per cent agreement on the classification of the control group stories.

To give a flavor of the difference between descriptions of the cerebral palsy group and the thema of the control group, the following examples are cited as illustrative. First, a thema given by a normal subject:

"Once there was a mother kangaroo and a baby kangaroo. Baby kangaroo and mother was going away to the circus. The baby couldn't ride his bicycle any more. He had to walk. Baby kangaroo was hitting his mother with a balloon so they took the balloon away from baby and the balloon accidentally broke and baby ran after the balloon. The baby climbed a tree and caught the balloon and he just got it and it hit a sharp rock and it broke and they went to the circus and he asked the man for a balloon and he got it" (Subject N2, Story 4).

Length is not important, but expression of affect is, as witnessed by the short thema on Card 6: "Seems to be a mommy and poppy bear and a little baby bear hiding in a cave. Looks like they're frightened." (Subject N5, Story 6).

By comparison now, here are descriptions, first by a normal: "Three chickens are going to eat all the porridge." (Tell a story?) "They'll eat all

the porridge." (Subject N5, Story 1). Here is nothing but the bare essentials, only a description commonly given. Second, a story classified "description" by a brain-injured subject: "The baby goat's riding a bike and the mother goat is carrying a basket with food and baby's carrying a balloon." (Anything else in the story?) "No." (Subject CP2, Story 4).

Something which the non-brain-injured never did, but which was done by 15 per cent of the brain-injured group, was to get so involved in the actual details of the picture that mere enumeration of small details took place. This is the phenomenon of concrete stimulus - boundedness described by Goldstein (7) and Strauss and Werner (11). The following is an example:

"This could be the monkey and this could be the tiger running up to the monkey to eat him. This could be the tree, this could be flowers, this could be the bottom, and this could be the back, this could be the leg, this could be the tail, this could be the water." (Subject CP8, Story 7).

Use of irrelevant details, ordinarily overlooked by the majority of subjects, but made to fit into the story occurs only in brain-injured subjects:

"This could be the father dog and this could be baby dog. In the bathroom. This could be the hanger for the towel, this could be the toilet, this could be the top of the toilet, this could be the chain." (What is happening?) "Baby dog is eating." (Why?) Subject points to the dog with mouth open. "See, he's hungry." (Subject CP8, Story 10).

Results

There is a striking difference between the number of descriptions given by cerebral palsied and non-brain-injured children. Table 1 shows, for example, that cerebral palsied children gave descriptions only to 61 per cent of the cards. Normals, on the other hand, gave only 28 per cent descriptions, and 72 per cent thema. This is a significant difference between groups beyond the .01 level of confidence.

Table 2 analyzes the results by individual subjects. The cerebral palsy and normal subjects are not paired, but numbered in random order. Considering the results from this table, it can be seen that the cerebral palsied child gives on the average 6.0 descriptions out of a possible 10. The normal child, on the other hand, gives less than half this number, on the average 2.8 descriptions out of a possible 10.

However, if we look at the individual cases more closely, we find that in the control group three cases contribute greatly to distorting the average number of descriptions given. These cases are Case 3 (eight descriptions), Case 4 (six descriptions), and Case 9 (eight descriptions). These cases were further investigated by the author. Cases 3 and 4 were children in public school with average intelligence and without psychological problems for over one year (as determined by the initial requirements for inclusion in

this control group). Nevertheless, when their teacher was questioned more closely, she admitted that although the children were no problem, they were both "strange" and sometimes had difficulty in coordination. It was not possible, despite further efforts, to obtain the necessary medical records or history to ascertain any previous brain injury. Case 9, a boy at the Emma Pendleton Bradley Home, was subsequently found to have a diagnosis of cerebral palsy, mild, secondary to behavior disorder.

This evidence, if it can be substantiated by validation study, appears to mean that the CAT, in terms of whether predominantly descriptions or predominantly thema are given, can distinguish between brain-injured and non-brain-injured children in the particular age range and mental age range studied. Intelligence does not appear to be a significant factor. Cerebral palsy Case 1, a boy with an IQ of 116, brighter than any subject of the control group, nevertheless, gave 7 out of 10 descriptions to the cards in the typically brain-injured manner.

Theoretical Implications

Theoretically, these qualitative differences between groups provide evidence for a discontinuity theory of genetic psychology. The brain-injured child's performance is qualitatively different from the non-brain-injured, and is on a lower more primitive level despite similarities of mental age.

Cerebral pasied children, like the organic adults described by Goldstein (7), show more concrete behavior than abstract, and more concrete behavior than non-brain-injured children of their same mental age. They appear relatively unable to adopt an abstract attitude to "tell a story," are stimulus-bound, and rigidly continue with the concrete attitude giving descriptions to the cards. This study corroborates Werner's interpretations of Rorschachs of brain-injured children (13), in which he found restricted fantasy life, forced responsiveness to stimuli, meticulousness, and difficulty in shifting.

Summary

In summary, the difference in approach to the CAT between cerebral palsied and non-brain-injured children is significant in terms of phenotypically giving more card descriptions than thema and genotypically in persisting in a concrete rather than an abstract attitude. This genotypic finding is related to similar conclusions, despite different cognitive or conative tasks, by Werner (13), Strauss and Werner (11), and Dolphin and Cruickshank (5). This study gives weight to a discontinuity theory of genetic psychology.

On the basis of the present results, if confirmed by validation studies, the CAT might serve as one psychological differentiator between brain-

injured and non-brain-injured children. Further research is required to determine the limits of mental ages which might be used as cut-off points to separate the two groups, the brain-injured and the non-brain-injured.

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THE EFFECTS OF A MOTOR HANDICAP ON PERSONALITY: III. THE EFFECTS ON CERTAIN FANTASIES AND ADJUSTIVE TECHNIQUES[1]

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Investigators of the personality characteristics of children with motor handicaps have emphasized the many emotional problems which arise in connection with such physical disabilities. Frequently mentioned are the effects on the child's body image, the special complications of dependency needs and the expression of hostile impulses, parental reactions of guilt, rejection or overprotection, and the peculiar social attitudes of the non-handicapped toward physical disability. The diverse and sometimes contradictory experimental findings also indicate the exceedingly complex nature of such problems. The present series of studies was designed to explore certain aspects of this general area.

STATEMENT OF THE PROBLEM

The following aspects of the handicapped child's emotional life were investigated: (1) his over-all adjustment; (2) the variety of his interests; (3) his fantasies of danger and destruction; and (4) his self-protective defenses. Since a different methodological approach was used, each aspect will be presented individually.

METHOD AND RESULTS

Subjects and Experimental Task

Data from the World Test were obtained from a group of 12 non-handicapped, 12 moderately handicapped, and 12 severely handicapped children. All were pupils in the Chicago public school system, between the ages of 8 and 10, of average or above intelligence, with no other severe physical handicap. Further details concerning the sample can be found in

[1] These studies were sponsored by The Coordinated Program for Handicapped Children and were done at The Institute for Psychosomatic and Psychiatric Research and Training, Michael Reese Hospital, Chicago, Ill.

the first paper of this series (5), while a description of the administration of the World Test to these subjects is given in the second paper (6).

Over-all Adjustment

One can hypothesize that the increased number of problems encountered by a child with a motor handicap will increase the probability of his becoming maladjusted. Thus it is possible that, as a group, the handicapped children will have a higher incidence of emotional disturbances of one sort or another than the non-handicapped children.

In order to test this hypothesis a measure of over-all adjustment was obtained by using the signs of emotional disturbance developed and validated by Buhler, Lumry and Carrol (2). These signs are: Aggressive Worlds (all play with aggressive content such as accidents, killing), Empty Worlds (less than 50 pieces,[2] less than 5 categories, no men and women used), Closed Worlds (the entire World or large parts fenced in or enclosed), Rigid Worlds (marked by exaggerated symmetry), and Disorganized Worlds (pieces placed chaotically). Each World was scored for the number of signs it contained and the mean number of signs for each group was calculated. These means are as follows: Non-Handicapped (N-H) Group—1.33 signs; Moderately Handicapped (M-H) Group—1.50 signs; Severely Handicapped (S-H) Group—1.17 signs. An analysis of variance yielded an F of .27 which fails to approach significance at the 5 per cent level of confidence.

However, Buhler *et al.* also claim that "the presence of two or more of these symptoms is highly discriminatory of abnormality" (p. 34). Therefore the number of children in each group with less than 2 signs and the number with 2 or more signs was calculated. This proportion was 7 to 5 in the N-H Group, 7 to 5 in the M-H Group, and 8 to 4 in the S-H Group. Since the proportions were so similar no statistical test of significance was deemed necessary.[3]

Therefore, there is no evidence that a motor handicap, per se, leads to a significantly higher incidence of general maladjustment than is found in non-handicapped children.

Variety of Interests

One can hypothesize that a motor handicap will produce a constriction of interest and a retreat from active involvement in interpersonal relations. This may be the consequence either of a realistic narrowing of the handi-

[2] This sign was omitted because the physical limitations of the handicapped groups forced them to use significantly fewer pieces.

[3] In Buhler's study the Normal group was selected on the criterion of good adjustment, whereas in the present study the Non-Handicapped children were selected without regard to their adjustment. Therefore it is not surprising to find a certain per cent of them falling into the maladjusted category.

capped child's range of experiences or of a protective withdrawal into simple, easily mastered activities.[4]

Decrease in the variety of objects used in constructing the World was used as one index of a narrowing of interests. To obtain a measure of this, the number of categories of pieces was computed for each group. Bolgar's categories (1) were used and include Houses, Public Buildings, Trees, Fences, Males, Females, Special People, Soldiers, Domestic Animals, Dogs, Wild Animals, Bridges, Vehicles, Details, Boats and Planes. The mean number of categories for each group was calculated and were as follows: N-H—13.08; M-H—13.33; S-H—10.67. An analysis of variance yielded an F of 1.75 which fails to approach significance at the 5 per cent level of confidence.

Therefore there is no evidence of a decrease in the variety of interests in the handicapped groups. This finding becomes more impressive when

TABLE 1

INTRODUCTION OF HUMAN PIECES

Group	*First Section*	*Second Section*	*None Used*
N-H	8	2	1
M-H	7	2	1
S-H	8	2	2

one remembers that there is a significant decrease in the total number of pieces used as the motor handicap becomes increasingly severe.

One might expect a retreat from active involvement in interpersonal relations to be expressed by a shying away from the use of people in constructing the Worlds. Thus the percentage of human pieces was computed and group means obtained. These means were as follows: N-H—16.33; M-H—21.83; S-H—21.83. An analysis of variance yielded an F of .65 which fails to approach significance at the 5 per cent level of confidence.

As a more refined approach to this problem, the data were examined in terms of the point at which human pieces were introduced into the construction. Thus the children with difficulties in interpersonal relations should introduce such pieces later in their construction than the less inhibited children. In order to obtain a measure of this factor, construction of the World was divided into thirds and the test was scored as to whether humans were introduced in the first, second, or third section. Since no child introduced such pieces in the third section, but some did not use human pieces at all, the category "None used" was substituted for the third

[4] The author is grateful to Dr. Hedda Bolgar for suggestions as to the analysis and interpretation of the World Test in the remaining sections of this paper.

section. The number of children in each group who introduced human pieces at the different stages of construction are presented in Table 1.[5] Because the proportions were so nearly equal, a chi square was not deemed necessary. Thus there is no evidence that children with a motor handicap retreat from interest in interpersonal relations.

Fantasies of Destruction

One can hypothesize that a motor handicap would increase a child's concern over destructiveness. It can be reasoned that the frustrations he experiences could intensify his own hostile, destructive impulses, and that his helplessness in many situations would lead to an exaggeration of the destructive forces in his environment.

To test this hypothesis, the Worlds were examined for all themes which showed concern over destruction. Such themes included interpersonal violence (war, fighting, arguments), fires, accidents, sickness, zoo or jungle scenes involving fighting, biting, or escape of wild animals. To be scored, the theme either had to be verbalized during the enquiry as a destructive theme per se or as a singling out of pieces with dangerous or destructive implications, or it had to be clearly indicated by the structure, such as elaborating the hospital with trees and a doctor going in the door. The pieces most frequently used in such themes were soldiers, wild animals, fire house and engines, hospital, doctor, sailor and policeman, although individual children showed great ingenuity in devising novel situations (e.g., a tree doctor coming to repair a diseased tree). The percentage of such pieces in the World was used as a measure of the child's concern with themes of destruction. The mean per cents of these destructive pieces were as follows: N-H—7.41; M-H—12.16; S-H—6.33. An analysis of variance yielded an F of 2.25 which fails to approach significance at the 5 per cent level of confidence.

However, inspection of the data indicated that in the handicapped groups themes of destruction were introduced much earlier in the construction; in fact, soldiers, wild animals and policemen were used as first pieces significantly more frequently in these groups. In order to discover whether the frequency of destructive themes differed significantly for the three groups at different stages of construction, a sequential analysis was undertaken. In this analysis the construction of the Worlds was divided into fifths, and the number of destructive pieces in each fifth was tabulated. The total number of destructive pieces in each segment is presented in Table 2.[6]

[5] The N in the groups does not always equal 12 because some cases were lost due to the author's failure to develop an adequate recording system for the sequential construction of the Worlds.

[6] Because of the author's failure to develop an adequate system of recording the sequential construction of the Worlds, the N in the groups are as follows: N-H, 8; M-H, 7; S-H, 10.

TABLE 2

NUMBER OF DESTRUCTIVE PIECES IN EACH SECTION

Group	*First*	*Second*	*Third*	*Fourth*	*Fifth*
N-H	3	6	5	7	11
M-H	9	3	2	2	3
S-H	2	2	6	2	2

A trend analysis yielded an F of 2.03 which approaches significance at the 5 per cent level of confidence. Thus there is a tendency for destructive themes to be used differently at consecutive stages of construction; in the Non-Handicapped group there is a gradual increase in such themes, in the Moderately Handicapped group there is an initial emphasis which tapers off quickly, and in the Severely Handicapped group the emphasis comes midway in the construction.

While there is no difference in the number of fantasies of destruction, the handicapped and non-handicapped children do differ significantly in their pattern of preoccupation with such fantasies.

Protective Defenses

One can hypothesize that the handicapped child will feel himself more vulnerable to internal and external threats and consequently will adopt rigid self-protective defenses. Thus he can isolate himself from the unpleasant aspects of his environment and protect himself from expressing dangerous impulses.

Buhler regards the use of fences in constructing a World as a measure of self-control, too many enclosures indicating high anxiety and rigid control, too few enclosures indicating impulsivity or a tendency toward disintegration. Therefore the percentage of fences was used as a measure of protective defenses. The mean per cents for each group were calculated and were as follows: N-H—30.38; M-H—20.67; S-H—15.92. An analysis of variance yielded an F of 5.49 which approaches significance at the 1 per cent level of confidence.

Therefore there is a significant decrease in the use of fences in children with a motor handicap, indicating a weakened ability to erect protective defenses against internal or external threats.

DISCUSSION

The present findings, based on the data from the World Test, indicate that a motor handicap, per se, does not increase the incidence of emotional disturbance, as there is the same proportion of adjusted and maladjusted

children in the handicapped and non-handicapped groups. There is also no evidence of a significant impoverishment of interests or retreat from interpersonal relations. On the contrary, the handicapped children's interests are as varied and their concern over interpersonal interactions is as great as the non-handicapped children's. Such findings, together with those of the previous study (6) emphasize the restitutive and compensatory mechanisms which are available to the handicapped children; they suggest a successful coping with many problems and a maintenance of an active and lively interest rather than a retreat into rigidity or apathy.

However, there is evidence that the motor handicap does entail significant personality changes. Most striking is a weakening of the ability to erect defenses which would result in a more stable kind of self-control. The non-handicapped child's characteristic pattern is one of initial inhibition of anxieties and angers which only gradually come to the surface. Corroborative evidence for this comes from other studies (3, 4) in which play material is used over a number of sessions. On the other hand, the handicapped group seems to be more immediately and more chronically vulnerable to feelings of threat, either from his own destructive impulses or from a world which he perceives as dangerous. Thus one can infer that the handicapped child does not have the type of self-control which would enable him to hold negative feelings in check and function on a more objective, realistic basis; on the contrary, his concern with internal or external dangers is often immediate and persistent. This weakening of emotional objectivity parallels the weakening of objectivity in setting realistic goals found in the first study of this series (5). Both findings suggest that emotional instability rather than rigidity is a primary effect of the motor handicap on personality.

Two methodological points should be made. The above conclusions were based on data from the World test which has been validated as to its diagnostic usefulness but not as to the criteria of fantasies of danger and self-protective defenses. Therefore the results should be accepted with the qualifications reserved for such procedures. One should also be cautioned against overgeneralizing the findings because of the limited nature of the sample, both in terms of size and age range. Second, the author was impressed in this study, as in a previous one (5), by the fruitfulness of a trend analysis. Future research, therefore, might well be concerned not only with discovering group differences in a given characteristic but with the temporal patterning of such characteristics. For example, in studying dependency it might be that the non-handicapped child is initially independent and will allow himself to become dependent only after a certain period of time, while the handicapped child might expect dependent gratifications much sooner. It is possible that many personality traits in handicapped children are no different quantitatively or qualitatively, but the organization of needs and defenses is changed.

SUMMARY

Analysis of the World Test administered to handicapped and non-handicapped children revealed the following results: There was no difference between the groups in terms of over-all adjustment, variety of interests and concern over interpersonal relations; there was also no difference in the number of destructive fantasies, but the handicapped children were significantly weaker in their ability to establish self-protective defenses and were more quickly or more chronically concerned with their destructive fantasies.

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A FACTOR ANALYSIS OF SOME ATTENTION-SEEKING BEHAVIORS OF YOUNG CHILDREN[1]

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PROBLEM

Though knowledge of the process underlying young children's behavior for attention and similar reinforcers might well be a key to understanding their general social interaction with both adults and peers, very little is known either about the dimensionality of their attention-seeking or about its antecedents. In the study herein reported an attempt is made to gain some leverage on the dimensionality of the behavior classes employed for attention by young children through a factor analysis of the correlations among nine items of behavior judged to be consonant with the characteristics generally attributed to attention-seeking and age.

Behavior for the reinforcer provided by the attention of people (attention-seeking) has usually been defined as falling under the more broadly defined concept "emotional dependence," along with such behaviors as those employed for approval, praise, physical contact and caresses, reassurance, and nearness. While the clinical literature is replete with case histories, mostly based on informal observation of children and adults with adjustment problems, which are described and interpreted in terms of such behavior concepts, the research literature reveals that few systematic attempts have been made to study the dimensionality of either emotional dependence or attention-seeking, or to determine their antecedents (1, 2, 3, 8, 12). Typically, relationships involving emotional dependence and attention-seeking in children have been found as by-products of general studies which addressed themselves to the consequences in children's behavior of broadly defined family attitudes or conditions of socialization, such as overprotection, deprivation, or rejection (e.g., 5, 6, 7, 10).

In order to further a systematic experimental investigation of the behaviors employed for attention and the antecedents of those behaviors, an experiment (4) was conducted on young children, which employed a situation in which each child could easel paint as long as he wished in the presence of an adult. The purpose was to investigate within the situational

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context of the experiment the relationships obtaining among several classes of behavior which logically could be expected to have been employed for attention (notice) from the adult, and three independent variables: the degree of apparent availability of the adult to the child (low versus high), the sex of the adult, and the sex of the child. The assumption underlying the use of these independent variables was that they provided stimulus conditions which were related to critical socialization experiences of the children, and therefore that singly or in combination they might be critical determinants of the behaviors of young children for the attention and perhaps the approval of adults. (Although attention- and approval-seeking in principle can be distinguished, for example by demonstrating differential emission of these behaviors as a function of whether attention or approval is delivered by the adult, for purposes of this investigation the two modes of behavior were formally confounded in the interests of the probable generality of the resulting data.)

The six response variables employed in the experiment were scored on a basis of frequency of occurrence. It was assumed that the first three variables listed very likely would be employed for the adult's attention (and/or approval) and that the last three variables also might be employed for that reinforcer. The variables were: *Attention-seeking,* which included urgent responses for overt notice from the adult; *Questions* casually asked, which required only brief replies from the adult; *Comments* casually made, which required no response from the adult; *Glances* directed momentarily toward the adult; number of *Paintings* completed; and *Time* in minutes the child remained in the session.

It was discovered that the children evidenced reliably greater mean frequencies of Attention-seeking and Glances under the low than under the high adult availability condition. And although, for the two conditions of availability, the means of Questions, Comments, Paintings and Time rank ordered identically as did the means of Attention-seeking and Glances, they were not reliably different from one another.

It was found also that the boys evidenced a reliably greater mean frequency of Attention-seeking responses with women than with men, but that the difference between the greater mean frequency of such responses employed with men than with women by the girls was not reliable. This differential response pattern was duplicated by the mean frequencies of Comments and Questions.

However, the dimensionality of attention-seeking, to the extent that it might be revealed in this experiment, is but incompletely indicated by the differential relationships between the dependent variables and the independent variables, and could be clarified by an analysis of the relationships among the six response variables employed. And since data bearing upon three additional response variables of the same class, *Help-seeking, Permission-seeking,* and *Praise-seeking,* which were not included in the above

study, were available, as was *Age* (in months) of the subjects (which could serve as a useful reference variable), the 10 variables were intercorrelated. A factor analysis of this inter-item correlation matrix could be of considerable use in determining the dimensionality of attention-seeking (and perhaps approval-seeking as well), especially when considered with the findings of the experiment, despite the limitations imposed by the moderate proportions of the matrix, the questionable or unknown nature of some of the distributions, observer reliabilities, and the stability through time of some of the behavior items, and the moderate size of the sample employed. Moreover, the results of the factor analysis could perhaps aid in interpreting the results of the experiment. The interpretations of the factor analysis are reported in this paper.

Experimental Procedure

Since the experimental method which generated the response variables analyzed is reported in detail elsewhere (4), only its critical features will be summarized here.

Sample

Twenty-eight boys and 28 girls were selected at random from among the white middle-class children at the University of Chicago Nursery School, with one control exercised: the age distributions were made relatively homogeneous for the eight experimental conditions. The subjects ranged in age from 4 years, 0 months, to 5 years, 7 months. The median age of the 28 boys was 4 years, 8 months; of the 28 girls, 4 years, 7 months.

Procedure

Each subject was escorted into the experimental room by the adult and informed that he could easel-paint as long as he wished, that he could request sheets of newsprint upon which to paint as he required them, and that when he no longer wished to paint, he was to inform the adult who would escort him back to his play group.

Independent Variables

The three experimental variables, degree of availability of the adult to the child, sex of the adult, and sex of the child, each included two levels in a 2 x 2 x 2 factorial design. Each child participated once under only one of the eight conditions of the experiment, making for eight treatment groups of seven children each.

Degree of adult availability. The two availability conditions differed only in one characteristic of the adult's role, his apparent availability to the child. Under the *high* availability condition, the adult sat close to the child, giving complete attention to him. Under the *low* availability condition, the

adult sat at a somewhat distant desk, busily working on papers. The adult responded to the initiations of the child in a uniform, standard manner under both conditions. His response was always friendly, yet brief, tailored to the character of the child's initiation, and engineered to terminate the interaction sequence. Responsibility for continuation of the sequence was always the child's. Thus the adult was as receptive to the children under the low as under the high availability condition.

Sex of adult interactor. Two men and two women, familiar to the children, each served as interactor under the four conditions which involved the adult of his or her own sex. Each served with approximately one-half of the subjects under every one of those four conditions.

Sex of child subject. Of the eight cells of the experimental design, four each included seven boys and four each included seven girls.

Dependent Variables

Of the 10 variables whose intercorrelations were factor analyzed, the relationships to the independent variables of the first six listed were studied in the experiment reported. It was postulated that under the conditions of the experiment each of the response classes might logically be expected to have been employed for the reinforcer provided by the receipt of attention (or approval) from the adult.

Attention-seeking. Included were responses, characterized by urgency, apparently designed for active notice from the adult. The adult's overt response indicated, in a manner appropriate to the child's request, that he was attending to the child. If an immediate response from the adult was not forthcoming (the adult delayed his response for three seconds, to insure correct categorization of the child's behavior), possibly the child would repeat his response several times until noticed. A typical sequence involved the child making his demand or asking his question, then pausing to direct his complete attention toward the adult while awaiting his reply. After the adult had responded, the child relaxed, either to continue his painting or to originate another sequence of behavior. Included in this category were requests and demands to have a statement heard, and responses like the following: "Will you look at this picture?" "What do you think this is a picture of?" "Look at me!" "You know what?"

Questions. Included in this category were casual questions, never urgent, which required only brief replies from the adult. The child typically continued his painting while awaiting a reply, and if he looked toward the adult at all, he did so momentarily. Aside from the fact that a reply from the adult was usually required, the tenor of the child's behavior was very much like that characteristic of Comments. An example is, "Why is the window open?"

Comments. Included were casual remarks (never urgent), which usually required no response from the adult. Typically the child made his re-

mark, and without pause either continued on to another remark or resumed his painting. He never attempted to insure either that the adult would hear or respond to his remark.

Glances. Included were the child's glances and stares at the adult, which neither involved verbal accompaniment, required responses from the adult, nor initiated sequences of interaction when it was apparent to the child that his glance had been noticed by the adult.

Paintings. When a child had informed the adult that he had completed a painting, the adult removed the painting from the easel, put up a blank sheet of newsprint in its place, and wrote the child's name in a corner of that sheet. The number of paintings on which the child worked during the session was recorded.

Time. The time elapsing from the point at which the subject took his place at the easel until he stated that he no longer wished to paint was recorded to the nearest minute.

Behaviors falling under the three categories listed below were recorded also, though they were not employed in the experiment:

Praise-seeking. Included were requests or demands for praise from the adult. In every other respect, the characteristics of this behavior class were identical with those of Attention-seeking (e.g., "Isn't my picture pretty?").

Help-seeking. Included were requests or demands for instrumental help or guidance from the adult (e.g., "Help me take this picture down").

Permission-seeking. Included were requests for permission from the adult for performance of an act (e.g., "What am I allowed to paint?").

Age. A tenth dependent variable, included to provide reference, was age in months of the subjects.

Reliabilities of the Response Variables

The observer reliabilities of the behavior categories, presented in the form of per cent agreement, were determined from two series of simultaneous yet independent observations made in the experimental setting by three observers. In the first series, 12 subjects not included in the sample were observed; in the second series, 16 of the first 30 experimental subjects were observed. Each of the eight experimental treatments was sampled at least once. The subject's responses were categorized both according to the definitions of the behavior variables and a standard recording procedure.

Every observer's record was aligned with the record of every other observer for each subject observed. All the records for each pairing of observers were combined for each observation series. Per cent observer agreement was computed according to the usual formula:

$$\% \text{ Agreement} = [\# \text{ Agreements} / (\# \text{ Agreements} + \# \text{ Disagreements})] \times 100.$$

An agreement was indicated by the assignment of a particular behavior to the same behavior category by two paired observers, and a disagreement was

indicated when they assigned a particular behavior to different categories or when one observer failed entirely to categorize the behavior.

The median of the per cent agreement figures of the two observation series was computed for each of the three observer pairs on each behavior variable; and the median of these three medians was computed in turn for each variable. The per cent agreement figures follow: Comments, 76; Questions, 80; Attention-seeking, 77; and Glances, 82. Because of the moderate occurrence of Help-seeking during the reliability observations, the observations of the three observer pairs were combined, to produce the single agreement figure, 73 per cent. The incidence of both Permission-seeking and Praise-seeking was low during the reliability observations and precluded obtaining meaningful reliability estimates for them.

The observer reliability figures for the behavior variables Comments, Questions, Attention-seeking, and Glances appear adequate; and while of questionable validity the reliability figure for Help-seeking is reassuring. The reliabilities of Permission-seeking and Praise-seeking are unknown. (It is probable that the low frequency of occurrence of Help-seeking, Permission-seeking and Praise-seeking under the conditions of the experiment, which precludes the effective assessment of their observer reliabilities, accounts also for their questionable distributions in the experiment.) Response

TABLE 1

THE INTER-ITEM CORRELATIONS *

	Attention-seeking	*Questions*	*Comments*	*Glances*	*Paintings*	*Time*	*Age*	*Praise-seeking*	*Help-seeking*	*Permission-seeking*
Attention-seeking	...	.631	.770	.235	.406	.241	.064	.500	.549	.398
Questions		...	.684	.122	.373	.010	—.146	.463	.571	.403
Comments			...	.213	.465	.253	.041	.415	.477	.331
Glances				...	.416	.589	—.110	.144	.086	.208
Paintings					...	.713	.277	.236	.404	—.009
Time						...	.153	.193	.304	.171
Age							...	—.029	.087	—.227
Praise-seeking								...	.368	.315
Help-seeking									...	.224
Permission-seeking										...

NOTE.—With the exception of Age, the scores for all variables were transformed into logarithms before correlation.

* The coefficients which are significant at the different levels, for 54 *df*, are: $p<.001$, .43; $p<.01$, .34; $p<.05$, .26; $p<.10$, .22.

category consistency, based on repeated observations of the subjects through time, was not determined.

The Correlations

In order to lessen the departure from normality of the distributions of frequency scores and to stabilize their variances, logarithmic scores were employed for the nine behavior variables. The Age (in months) variable was not transformed. Product-moment coefficients were calculated for the correlations among the 10 variables.

Because the frequency distributions of the variables Help-seeking, Permission-seeking, and Praise-seeking included relatively many zero scores, it is doubtful that they would be normalized effectively by transformation. Thus the correlation coefficients between these three and the other seven variables are not readily interpretable. And since their observer reliabilities are for all purposes unknown, the coefficients involving the three variables have been segregated and listed last in the table of inter-item correlations (Table 1), and the results of this study which depend upon them will be interpreted with considerable caution.

The correlation coefficients employed were calculated from the transformed experimental scores. Since the experimental procedure and the treatment employed in the study have been established to represent conditions under which children do make those initiations which fall under the nine behavior item categories employed, and since several of these categories were successfully related to independent variables hypothesized to be relevant, it would not seem unreasonable to generalize the correlations obtained to the variety of social settings in which a child and an adult are involved.[3]

The Factor Analysis

Method

The centroid method of multiple factor analysis, developed by Thurstone (11), is employed in this study. The matrix of centroid factor loadings is presented in Table 2. Four centroid factors were extracted from the correlation matrix.

In the present investigation, the decision was made to call centroid factor IV a residual for three overlapping reasons: first, seven of its 10 factor loadings were of zero order; second, it accounted for so little of the

[3] An analysis of the differences between the correlation coefficients employed (54 *df*) which were determined upon the experimental scores, and the within-groups (residual, error) coefficients (47 *df*) for the intercorrelations among the first seven variables in Table 1 can support this point. Within-groups correlations are by their natures corrected for the effects of experimental treatments. In principle, then, they might be generalized to a wide variety of treatment conditions. The analysis indicates that for the 21 pairs of coefficients involved in the comparison of experimental score correlations with the within-groups correlations, the median difference between members of pairs was .02, and the largest difference .11. In no case is it likely that a difference is statistically stable.

TABLE 2

CENTROID FACTOR LOADINGS

Item	*Centroid Factors* I	II	III	IV	h^2 *
1. Attention-seeking	.816	.301	.058	.261	.828
2. Questions	.693	.508	.102	—.308	.844
3. Comments	.774	.245	.156	.190	.720
4. Glances	.421	—.339	—.402	.036	.455
5. Paintings	.729	—.512	.255	—.101	.869
6. Time	.607	—.678	—.238	.023	.885
7. Age	.054	—.236	.384	.052	.209
8. Praise-seeking	.525	.232	—.082	—.019	.337
9. Help-seeking	.627	.144	.147	—.119	.450
10. Permission-seeking	.376	.335	—.380	.037	.399
$\Sigma k^2/n$ †	.364	.149	.064	.023	.600‡

* Communality.

† Estimate of proportion of total item variance attributable to a factor.

‡ $\Sigma h^2/n = \Sigma(\Sigma k^2/n)$.

average item variance that it appeared highly improbable that it would yield an interpretable factor; and, third, it did not yield simple structure upon rotation.

Rotations. Orthogonal rotations of the centroid factors were accomplished employing a graphical modification of Thurstone's methods (13). An orthogonal solution rather than an oblique solution was employed primarily because of its advantages of relative conceptual simplicity and economy of labor. It is not assumed that if the oblique method were employed, the factors extracted necessarily would be independent of one another. In

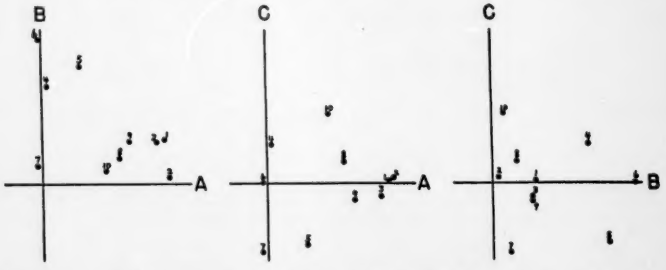

FIGURE 1—Two-dimensional plots of each rotated factor against the other two factors.

TABLE 3

ROTATED FACTOR LOADINGS

Item	*Rotated Factors* A	B	C	h^2 *
1. Attention-seeking	.82	.28	.02	.75
2. Questions	.85	.04	.04	.73
3. Comments	.77	.27	—.09	.67
4. Glances	.03	.64	.25	.47
5. Paintings	.27	.77	—.38	.81
6. Time	—.02	.95	.00	.90
7. Age	—.03	.12	—.45	.22
8. Praise-seeking	.52	.17	.14	.32
9. Help-seeking	.58	.27	—.11	.42
10. Permission-seeking	.42	.08	.46	.39
$\Sigma h^2/n$ †	.28	.22	.07	.57‡

* Communality.

† Estimate of proportion of total item variance attributable to a factor.

‡ $\Sigma h^2/n = \Sigma(\Sigma h^2/n)$.

Table 3 appear the rotated factor loadings, while in Figure 1 appear the two-dimensional plots of each rotated factor against the other two factors.

Criteria for interpretation of factor loadings. Because of the questionable validity of the correlations involving the three variables Praise-, Help-, and Permission-seeking, the interpretation of a factor defined only by one or more of those variables would be seriously limited indeed. For this reason, and because of the moderate number of cases studied, rather conservative criteria are employed in the interpretations of the factor loadings, as follows: Loadings of $\pm$.60 and above are considered high, and are taken to define the meaning of a factor; loadings of $\pm$.30 to .59 are considered moderate, and must be consistent with the definition of the factor; loadings of $\pm$.20 to .29 are considered low, and while not taken seriously into account, they are employed to clarify the meaning of a factor; and loadings of less than $\pm$.20 are considered negligible.

We may now move to the consideration of the interpretations of the factors.

Factor A

The factor most clearly identified in the present study is Factor A. In Table 3 it is seen that this factor accounts for the largest proportion (.28) of the total item variance. In that seven out of the nine behavior items show appreciable loadings on A, it might almost be called a general factor. Since the communalities of the items for the three rotated factors average .57,

Factor A accounts for approximately 50 per cent of the variance in the item intercorrelations accounted for by the three factors extracted.

Those behavior items having projections on Factor A, which are of interest according to the criteria advanced, are listed below:

	Item	*Loading on Factor A*
2.	Questions	.85
1.	Attention-seeking	.82
3.	Comments	.77
9.	Help-seeking	.58
8.	Praise-seeking	.52
10.	Permission-seeking	.42
5.	Paintings	.27

The three behavior items which define this factor are verbal in character. Thus, the factor might ordinarily be labeled "talkativeness" or the like. However, in this experiment, where these behavior items related differentially to the experimental variables roughly according to hypotheses advanced, it appears reasonable to emphasize that characteristic of them which was responsible for their initial selection. In the context of the experimental setting, Attention-seeking, Questions, and Comments all appear to involve an active attempt *to gain or to maintain the adult's attention*. The major dimension along which the behavior items appear to differ is in the degree to which their initiations for attention are overt or direct. The analysis, which is detailed below, indicates that this interpretation of the factor solution fits well with a number of reasonable assumptions.

Attention-seeking responses were apparently employed by the child overtly to gain the attention of the adult; he paused in his ongoing action, giving his complete attention to the adult until his request had been answered by the adult's overt response.

Casual Questions overlapped with Attention-seeking in two ways. First, urgent questions have been defined in this study to fall under the Attention-seeking behavior category; on this basis alone Questions might have been expected to enter into relationships parallel to those found for Attention-seeking, and, perhaps as well, relationships with Attention-seeking. And, second, while it was not as apparent as was the case with Attention-seeking that Questions were employed to gain the attention of the adult, since they might have been employed as well for other reinforcers (such as those provided by the information included in the overt replies they required), the demand for a reply which is inherent in the nature of the casual question actually could gain the attention of the adult for the child. Thus, Questions may frequently have been employed by the children solely for the reinforcer provided by the adult's attention.

While casual Comments did not appear overtly to have been employed to gain the adult's attention, in a room of moderate size where a distance of no more than six feet separated the child from the permissive adult, it would not have been unreasonable for the child to expect that his every remark would be noticed by the adult. Thus, while Comments, like Ques-

tions, might have been emitted for reinforcers other than those provided by the adult's attention, because of the nature of the interaction setting, they reasonably might be expected to have been employed frequently to gain that attention.

The interpretation of Factor A advanced in the preceding paragraphs would apply as well to Help-seeking, Praise-seeking, and Permission-seeking, which three behavior items have moderate loadings on the factor. Each of those behaviors could also be expected to have been employed to gain or to maintain the attention or approval of the adult.

Help-seeking logically might have been employed solely for the reinforcers involved in the receipt of help. However, since such requests required an overt response from the adult, they could effectively have gained his attention. Moreover, requests for help could place the child in a dependent role relative to the adult; and since it could have been expected that an adult would ordinarily offer attention to a dependent child, some children might have attempted to appear dependent in order to gain the adult's attention.

Praise-seeking might be expected to have been employed to gain the approval (and attention) of the adult, and is seen to have much in common with Attention-seeking. Similarly Permission-seeking could be expected to have been employed to retain or to gain the approval of the adult, since by such requests children can appear compliant ("good"). Moreover, since Permission-seeking requests require some response from the adult, they might have been employed on occasion directly for the attention provided by the adult.

It is noted in concluding this interpretation that not one of the verbal behavior items is missing from the list of items which have at least moderate loadings on this factor. Moreover, it is reassuring to note that the three behavior items about which some question was raised have moderate loadings on this factor, and are quite consistent with the interpretation advanced.

Factor B

Next most clearly identified in the present study is Factor B, whose loadings account for 22 per cent of the average item variance. On this factor, three items have high loadings, while three items have low to moderate loadings. The factor accounts for approximately 37 per cent of the variance in the inter-item correlations accounted for by the three factors extracted. The items which have appreciable loadings on Factor B are:

	Item	*Loading on Factor B*
6.	Time	.95
5.	Paintings	.77
4.	Glances	.64
1.	Attention-seeking	.28
3.	Comments	.27
9.	Help-seeking	.27

Factor B describes a pattern wherein children who remain in the experimental setting for longer periods of time completed greater numbers of paintings and employed greater numbers of glances at the adult. Put somewhat differently, the children who remained in the setting longer, and completed more paintings, emitted relatively few verbal responses to the adult (identified as attention-seeking according to the interpretation of Factor A). Rather they glanced at the adult frequently.

The three behavior items which define Factor B are nonverbal in character. Both Time, which is essentially a pure item factorially, and Paintings are characterized by compliance with the instructional set given the children to paint. Several alternative and more or less reasonable interpretations of Factor B can be advanced on the basis of the three behavior items which define it. The factor might involve a response pattern which:

a. Reflected the child's enjoyment of the painting task, and his consequent expenditure of time in it.

b. Reflected passive compliance with the requirements of the instructional set by the disinterested, docile child, who might perhaps have been socially apprehensive as well.

c. Was employed for the adult's attention and approval by the passive, docile child who hesitated to employ active verbal responses like those which characterize Factor A; or by the child who for some reason was in conflict over employing that more direct response pattern.

d. Was achievement-oriented to the task prescribed for the adult's attention and/or approval. This pattern might have been employed by relatively mature children, for whom compliance was the most appropriate response for the adult's attention or approval, and/or by the children who did not "seek" verbal assurance that the adult was available to them.

Of the four possibilities, interpretations *c* and *d* are believed to be the most reasonable, although interpretations *a* and *b* present the greater appeal to apparent parsimony. This conclusion is supported by the following reasoning: Both the child deriving considerable enjoyment from the task itself and the compliant, docile child disinterested in the task might have evidenced high scores on Time, Paintings, and Glances. These types could reasonably be expected to spend a considerable amount of time in the situation, either because of enjoyment of the task, or to satisfy the adult's instructions. On either basis, it follows that a relatively large number of paintings would be completed. And finally, if it is assumed that Glances have a reasonably uniform distribution through time, i.e., that their rate is fairly stable, then expenditure of time implies a correspondingly high frequency of Glances.

However, in the analysis of the results of the experiment, when the relationship between Glances and the independent variable Degree of Adult Availability was assessed and the glance scores corrected for their regression

upon Time, it was found that children employed reliably greater frequencies of both Attention-seeking and Glances under low availability than under high availability, although the correlation between those two dependent variables did not attain significance at the .05 level. Thus, Glances could not have been accounted for completely by Time, nor could the relationship between the two have been accounted for by the independent variable Degree of Adult Availability. Hence, it follows that Glances reflects other determinants, presumably related to attention- or approval-seeking, in addition to those reflected by Time, and this finding detracts seriously from the apparent parsimony of interpretation *a*, and, to a lesser extent, of interpretation *b*. Put differently, it appears that there might have been at least two (perhaps more) qualitatively different types of glances.

Glances might have been employed directly by the child for the adult's attention and approval, for compliance, for painting products, or for "being a child" in the situation; for the child might well have expected that if his glance were noticed by the adult, he would be attended to. As such, Glances might have been responses alternative to Attention-seeking, Questions, and Comments, in that a high glance score for a child might mean only that on a high proportion of times he looked at the adult, he made no verbal requests or statements.

In addition to the possibility that they were employed for attention and approval, Glances might have been employed by the children simply to help them to ascertain what was occurring around them, or pehaps to understand the situation which was not, after all, one with which they were highly familiar. Moreover, Glances might have represented simply attempts by children to ascertain if the adult was still content to allow them to continue with the enjoyable painting task. And it is also possible that Glances might simply have been indicators of uneasiness or apprehension in the children.

If the loading of Glances on Factor C, which will be interpreted provisionally to involve inexperience or apprehensiveness, is taken to reflect the proportion of occasions when they served as indicators of uneasiness, then their loading on Factor B might be taken to reflect primarily behavior for the reinforcers of attention or approval alone. This logic would lend support primarily to alternative factor interpretations *c* or *d*.

These interpretations receive additional support from the following reasoning: Since the adult had informed the child that he might paint as long as he wished, the child must have realized that to remain in the setting and to paint would satisfy the adult. Moreover, it is recalled that when the child informed the adult that he had completed a painting, the adult took it down from the easel, replaced it with a fresh sheet of newsprint and wrote the child's name in the corner of that sheet. In servicing the easel, then, the adult attended to the child, and to the extent that completing a

painting was an achievement, the adult's attention would have signified approval to the child. Thus, it is in order to suggest that the child might have completed paintings to gain the attention and approval of the adult, as it may be suggested that the response of remaining in the setting, reflected in Time, might have been employed in a like manner.

The remaining factor loadings of Attention-seeking, Comments, and Help-seeking, all low, would appear to be in keeping with interpretations *c* and *d*. Attention-seeking and Comments define and Help-seeking has a moderate loading on Factor A, which was interpreted to involve active verbal attention-seeking.

Thus, though it is not possible from the pattern of loadings found for this factor conclusively to select from among the several possible interpretations, it is thought most likely that Factor B reflects behavior for the reinforcer of attention (approval), and that it does not reflect inexperience, apprehensiveness, or simple enjoyment of the task. However, it is conceivable that several of the interpretations advanced hold simultaneously; for several of the hypothesized types of children—active approval-oriented, docile approval-oriented, docile disinterested, and those who simply enjoyed painting —characterized by this factor pattern might have been represented in the sample employed.

In order to allow selection from the possibilities discussed, a factor analysis study could be planned which would include, in addition to the variables employed in the study, response variables selected effectively to isolate the different interpretations. Alternatively, selected independent variable treatment conditions could be employed to serve a similar end.

Factor C

Least clearly identified in the present study is Factor C, which accounts for only 7 per cent of the average item variance. While no item is found to have a high loading on this factor, three items have moderate loadings and one item has a low loading. The items which have non-zero loadings on this factor are listed below:

	Item	*Loading on Factor C*
10.	Permission-seeking	.46
7.	Age	—.45
5.	Paintings	—.38
4.	Glances	.25

Ordinarily one would hesitate to attempt to interpret a factor which is specified by items with only moderate loadings, and one would be especially cautious when the factor accounts for such a small amount of the average item variance. However, in this instance the meaningful grouping of the items would appear at least to support an attempt at interpretation.

An examination of the items with moderate loadings on this factor indicates, although clear definition is not possible, that the tendency embodied may be interpreted provisionally as involving either (or both) of two related processes, both perhaps to some extent determined by the relative immaturity of children in the age range from four to five and one-half years: (*a*) apprehensiveness, either general in nature or about losing the adult's approval; and/or (*b*) inability or inexperience in painting.

It is recalled that when Factor A was interpreted, the suggestion was advanced that requests for permission might be expected to have been employed to gain the adult's attention; and, in that they entailed compliance, they might have been employed to retain the adult's approval. It is reasonable to expect that young children in the age range studied, being relatively immature, would tend to employ such responses. Moreover, younger children might find it difficult to concentrate on producing paintings, or not have the ability to do so. And following from the assumption that the high loading of Glances on Factor B accounts for their having been employed for attention and approval, their loading on Factor C might reflect their having been indicators of inexperience and apprehensiveness.

Thus, it appears that the behavior pattern wherein younger children request permission more frequently, complete fewer paintings and emit more frequent glances, makes considerable sense. However, it is again proper to emphasize that this factor was not most clearly defined, that Permission-seeking has both a questionable distribution of scores and an essentially unknown reliability, that it is impossible to select from among the alternative interpretations (which overlap considerably), and that other reasonable interpretations might be possible.

Discussion

The basic logic of the approach of this study has been that the behaviors scored could be said to have been employed for the reinforcers of attention, and possibly approval, on a basis of the structure of the experimental situation. That is, on certain logical and empirical grounds a situation was devised in which the emission of certain behaviors (which in other contexts might mean a number of things) could logically be expected to represent attention-seeking; and those behaviors were defined as such. Since the design of this study precluded the demonstration of the existence of a functional relationship between the emission of these behaviors and the receipt of attention, the logic of the nature of the experimental setting stands as the basic justification for labeling the behaviors studied attention-seeking; and the consonance of the factor loadings with this interpretation and the reassuring relationships obtaining between several of these dependent variables and certain combinations of experimental variables constitute auxiliary support for the basic assumption employed (and constitute as well new information about the behaviors).

The Results

On the basis of an analysis of their characteristics it was expected that some of these behavior items might fall together to define factors. In general this proved to be the case, particularly for the six behavior items whose relationships to three experimental variables were determined in the investigation reported earlier. It was assumed for the experimental conditions employed that Attention-seeking, Questions, and Comments might all three be employed similarly for the reinforcer provided by the attention of the adult, and therefore that they might correlate with each other and relate similarly to the independent variables. The results of the factor analysis to an extent support that assumption, and indicated that those three behavior items all have rather high loadings on, and defined, Factor A, which was interpreted provisionally to involve active attempts to gain the attention of the adult. It will be recalled that although the means for those three variables tended to rank-order similarly for the different experimental combinations, reliable effects were found through an analysis of variance only for Attention-seeking, while the effects for Comments approached significance.

It was assumed further for the conditions of the experiment that the nonverbal behavior items, Paintings, Time and Glances, might also have been employed for the reinforcer provided by the adult's attention or approval. It was expected, therefore, that they might relate to Attention-seeking, Questions and Comments, and enter as well into similar relationships with the experimental variables, or that they might in both cases relate as might an alternative response pattern.

It will be recalled that one of the alternative interpretations of Factor B was that it involved a nonverbal pattern of behavior for the reinforcer of attention or approval, which was different from the active verbal form characteristic of Factor A. While Time, Paintings, and Glances had high loadings on Factor B, with the exception of the low loading of Paintings, they had no loadings on Factor A, as should have been the case if they were highly related to Attention-seeking, Questions and Comments. Moreover, neither Time nor Paintings related at all to the experimental variables. Glances however related to the apparent availability conditions similarly as did Attention-seeking. The ambiguity involved in the interpretation of Factor B does not detract from its well-defined status in this investigation.

Because the variables included in the analysis of variance differed in several important respects from those included in the factor analysis, it would not be fruitful to compare in any greater detail the results of the experiment, in which the behavior items were related to independent variables, with the results of the factor analysis, in which the common elements in the relationships among the behavior items were determined.

It is of interest to note that the nine behavior items selected initially in the context of the experiment to appeal to a presumed single dimension of attention-seeking, should (with the reference variable of age) yield

at least two and perhaps three factors. This apparent multidimensional character of attention-seeking in experimental settings like the one in this study could provide a useful basis for future investigations of both its dimensionality and its antecedents.

Behavior Antecedents

The results obtained indicate that it was not unreasonable to advance as a basic assumption the proposition that behaviors like Attention-seeking, Questions, and Comments directed toward adults were frequently reinforced (particularly with generalized reinforcers (9) like attention and approval) during early childhood, and hence that an experimental setting which furnished children with access to a permissive adult would provide the occasion for such behaviors to be employed for those reinforcers.

It is assumed that for any child the hierarchy of reinforcers and of responses employed to gain those reinforcers would depend upon his particular reinforcement history. Thus, some children might characteristically seek approval, while others might simply seek attention; and some children might characteristically employ behavior overtly directed toward gaining a particular reinforcer (e.g., Attention-seeking), while others might employ behavior which perhaps could gain the reinforcer indirectly (e.g., Questions or Comments).

It is conceivable that other than simple characteristics of the reinforcement histories of the children could account also for the different degrees to which different responses (e.g., those which might be characterized as either direct of indirect) are employed for attention. If it is assumed that the overt (direct) response for attention most readily gains that reinforcer, then it is conceivable that those children who might have been in conflict over employing that response (which can be assumed to be a joint function of the subject's history of positive and negative reinforcement for the response) might have employed a displaced (e.g., indirect) response for attention. Of course, the responses labeled indirect might have been employed frequently because they have been learned as appropriate in given circumstances, and not as responses to conflict.

Moreover, the indirect response for attention might have been employed by children on occasions when, for whatever reason, it was critical for them to gain attention, for the indirect response by its nature does not appear readily to invite rejection, and could have insured that an adult would take notice of the child. Likewise, characteristics of the sequence of responses might have played a role in determining whether, for example, direct or indirect responses were employed for attention. When a response over which the child was in conflict was employed for any reason, the child's conflict might have become heightened, and as a consequence, subsequent responses emitted by him in the series might have been displaced.

If it is assumed that a process like that of conflict might have operated at least in part to determine the relationships among the behavior variables in this investigation, then those relationships would have been obscured. An investigation which introduced differential conflict in terms of selected independent variables would be required to gain leverage upon the question.

In concluding these considerations, it appears not unreasonable to assume that the generalized reinforcer (9, p. 77) provided by the attention or by the approval of the adult, which so frequently determines the child's behavior, is effective because it signifies to the child (on some latent level), that upon further request he might receive other, critical reinforcers (food, etc.) which an attending or approving adult can supply.

Methodological Considerations

It appears that the factor analysis has helped to organize a domain which heretofore has been essentially unexplored. Since this study opens a new domain to investigation and there is little precedent which can be employed to aid in the interpretation of the findings, reason for caution obtains. Rather than providing decisive evidence for a given hypothesis, the interpretations of the results are indicative of the directions in which future investigations might move fruitfully. The factors isolated suggest how the behavior items employed might be combined or improved, and, as well, the natures of other behavior items which might be investigated.

Although a number of the apparently reasonable factor interpretations are consonant with assumptions of attention- (and approval-) seeking, it is well to emphasize that all the factor interpretations advanced in this paper are *ad hoc*; and further, that they are limited by the subjective element in factor rotations, by sampling instability of the inter-item correlation coefficients, by unknown observer reliability and item consistency of several of the behavior items, and by the fact that the data were collected with reference to the treatment conditions of an experiment.

In the present study factors were defined by considering the nature of items exhibiting high factor saturations. As a task for the future, a more comprehensive analysis would be desirable, in which a larger number of reliable behavior items would be employed, perhaps selected to differentiate among the alternative factor interpretations, as would be a larger number of subjects to insure sampling stability, and behavior items which yield more normal distributions. The nature of the items could be more adequately determined in this manner, and factors could be defined with greater confidence. Moreover, by employing as subjects children at several age levels, the developmental characteristics of the factors could be explored.

Summary

In an experiment reported elsewhere (4), each of 56 children could easel paint as long as he wished in the presence of an adult. The experimental

conditions employed were degree of apparent availability of the adult to the child (low versus high), sex of the adult, and sex of the child. The children's behaviors were classified in nine categories, each of which, according to reasonable assumptions, could be expected to have been employed in the experimental context for the reinforcer of attention or approval from the adult. It was thought that a factor analysis of the inter-item correlation matrix could be of use in clarifying the dimensionality of attention-seeking.

The nine behavior items, together with age, were intercorrelated, forming a matrix of moderate proportions. This matrix of intercorrelations was subjected to a graphical modification of Thurstone's methods of multiple factor analysis. After orthogonal rotations of the four centroid factors which were extracted, three apparently meaningful factors appeared. Factors A and B were more clearly defined than Factor C. However, only Factor A, and to a lesser extent Factor C, appeared to lend themselves to ready psychological interpretations. The factor interpretations follow:

Factor A which was most clearly defined was interpreted as involving an active (verbal) attempt to gain or to maintain the attention of the adult.

Factor B, which was next most clearly defined, was difficult to interpret. Several alternative and more or less reasonable interpretations were advanced. It was thought most likely that the factor involved either: (*a*) an achievement-oriented response pattern to the task prescribed, employed for the adult's attention or approval by relatively mature children or by children who did not require verbal assurance that the adult was available to them; or (*b*) a response pattern for attention or approval employed by the passive, docile, child, or by the child in conflict over employing the more direct response pattern. That Factor B reflected either the child's enjoyment of the painting task or passive compliance with the instructions by the disinterested docile child could not be ruled out completely as interpretations.

Factor C, which was least clearly defined, was interpreted provisionally as involving either or both of two related processes, perhaps to some extent reflecting relative immaturity of some of the children, as follows: apprehensiveness, either general in nature or about losing the adult's approval; and/or inability or inexperience in painting.

Assumptions were set forth concerning the role of certain stimulus events in critical socialization settings, and implications for consequences susceptible to experimental investigation were discussed.

Because of limitations in the data and the method, the results were evaluated with considerable caution. It was concluded that the factor analysis helped, if only to a modest degree, to organize a domain which heretofore has been essentially unexplored.

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THE EFFECTS OF NUMBER OF REINFORCEMENTS ON THE STRENGTH OF A GENERALIZED INSTRUMENTAL RESPONSE

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The importance of the principle of stimulus generalization in behavior theory, and especially in stimulus-response theories of behavior, is generally recognized. The principle has been used to explain such diverse phenomena as the occurrence of sudden or insightful solutions of problems, and the maladaptive persistence of behavior that is not rewarded or is even punished. Despite the crucial role that stimulus generalization has played in stimulus-response accounts of behavioral phenomena, important empirical data are still missing from the literature (12).

The principle has recently taken on added significance through its application by experimenters to the explanation of results obtained from studies of the discrimination learning performance of children (1, 2, 3, 4, 7, 8, 13). In some of these experiments, the related principles of mediated generalization and acquired distinctiveness of cues (11) have also been applied. Thus, it is desirable to devise experimental conditions and apparatus that are appropriate for children and which may also be used to verify and extend some of the important findings in the area, now based primarily on the study of infrahuman and human adult subjects.

One of the important variables assumed to affect the generalization of a response is the number of reinforcements given on the training stimulus. Razran (12) reports that the evidence from classical conditioning with infrahuman and human adult subjects demonstrates fairly conclusively that an increase in the number of reinforcements on the training (conditioned) stimulus results in an increased amount of generalization to the test stimuli. A recent study with rats by Margolius (10) reports an increase in the strength of a generalized instrumental response with increased numbers of reinforcements on the conditioned stimulus.

PROBLEM

The present experiment is concerned with the development of a procedure adequate to study generalization in preschool children, and to test the explicit hypothesis that an increase in the number of reinforcements on the training stimulus results in increased strength of the generalized

[1] The writer is indebted to his research assistants, Mr. Lewis P. Lipsitt and Miss Kathryn Norcross, for assistance in the collection of the data.

response. The method whereby the conditioned stimulus is presented and the subject (*S*) is trained to make a single response was rejected when preliminary work with children proved it to be rather insensitive to variations in the amount of training. On the other hand, the operant conditioning technique, used with children by Warren and Brown (16), was also rejected since it does not allow for convenient manipulation of stimulus similarity. Instead, a combination of these two methods was developed, in which a stimulus is presented for a set period of time and, during the stimulus presentation, *S* is allowed to respond repeatedly with reinforcement following each response. Response strength is assumed to be reflected in the number of responses made during the presentation interval. This assumption appears tenable in view of the tendency for the *S*s to chain the responses: that is, after a few trials, they tend to pull repeatedly without checking for the occurrence or nonoccurrence of reinforcement until the stimulus has disappeared.

In this procedure, then, *S* learns to pull the lever repeatedly during the period that the conditioned stimulus is present and to cease pulling the lever when it disappears. Following training on this problem, he is presented with the test stimuli, and his tendencies to pull the lever to these stimuli are observed.

Method

Subjects

The *S*s were 36 children from the Iowa Child Welfare Research Station preschool laboratories, ranging in age from 4 years, 3 months, to 5 years, 6 months. Eighteen *S*s were assigned at random to one group, and were given 12 reinforcement trials (Group 12); the other 18 were assigned to a group given 24 reinforcement trials (Group 24). Within each of these two groups, 6 *S*s were assigned to each of three subgroups that differed only in the order in which the test stimuli were presented. Twelve additional *S*s were run in the experiment but were eliminated for reasons listed in the section describing procedures for preliminary training.

Apparatus

The experiment was conducted in a semi-darkened experimental room with an adjoining observation room. The apparatus was placed in the window between the two rooms, approximately 33 in. above the floor. *S* operated the apparatus from the experimental room while the experimenter (*E*) operated the controls and recorded *S*'s responses from the observation booth. As *S* viewed the apparatus, it consisted of a gray metal panel 20 in. wide and 12 in. high. Three in. from the top was centered an aperture, 2 in. in diameter, covered with flashed opal glass. A ¾ in. copper tube, 5 in. below and 4 in. to the left of the center of the aperture, led to a transparent container fastened at the base of the apparatus. A metal rod with

a hand grip extended from the apparatus 5 in. below and 4 in. to the right of the stimulus aperture. Directly below the apparatus was a wooden stand, 2 ft. square and 8 in. high, on which *S* stood during the experiment. The stand served the double purpose of restricting the child's movements during the experiment and raising him to a level convenient for operating the lever and observing the stimuli.

The apparatus was enclosed in a metal cabinet, 12 in. high, 20 in. wide, and 12 in. deep. The front face of the cabinet was that presented to *S*. Approximately 7 in. behind the aperture were four 75-watt projection lamps, arranged so that their beams focused on the aperture. Each lamp was enclosed in a reflecting container on the front of which a 2 in. square glass color filter could be inserted. A solenoid-operated marble ejector was mounted inside the front face of the cabinet. The marble magazine, containing 200 marbles, extended from the top of the cabinet and was mounted on the walls of *E*'s control room.

The circuits to the projector lamps ran through a 10-bank, 25-contact stepping relay (Rotary Type 45, Automatic Elec. Sales Corp.), which in turn was controlled by two Hunter Decade-Type Interval Timers (6). One of the timers controlled the presentation interval and the other controlled the interval between presentations. A multi-contact selector switch was wired into the circuit in such a way that any of the 10 banks on the stepping relay could be used. These banks determined which stimuli would be presented and the order in which they would be presented.

Each pull of the response lever over a distance of ¾ in. activated one of four electrical impulse counters, provided a stimulus lamp was on at the time the response occurred. The circuit was arranged so that a response to each stimulus was recorded on a separate counter. The number of responses made to a given stimulus was readily obtained for each presentation. Approximately 8 pounds of pressure were required to move the lever the ¾ in. necessary to activate the counters and the marble ejector. The marble ejector could be activated only on those trials in which the training stimulus was present.

Stimuli

The stimuli were lights of different hue obtained by shining the beams of the projector lamps through glass color filters obtained from the Corning Glass Co. The training stimulus was a deep blue (Filter No. 5543), the first test stimulus was a light blue (No. 5031), the second was a blue-green (No. 4060), and the third was a green (No. 4010). The stimuli were not equated for brightness, Nos. 5543 and 4010 appearing to be considerably dimmer than the other two.

Preliminary Training

S was brought into the experimental room, shown a variety of dime-store toys spread out on a small table, and allowed to choose the toy that he

wished to have. He was then informed that he must pay for the toy with marbles and that *E* would show him how to get some marbles. *E* then turned on the apparatus, setting it to present a series of training stimuli. This series consisted of 4-second presentations of the training stimulus separated by 2½-second inter-presentation intervals. *E* pulled the lever several times while the training light was on, pointed to the marbles that were being ejected, and instructed *S* that pulling the lever made the marbles fall into the container. Following this demonstration, *S* was allowed to pull the lever to obtain marbles. The preliminary training was continued until, for several consecutive trials, *S* began to pull more than once per light and stopped pulling during the inter-trial interval. Twelve *S*s were eliminated from the experiment, six in each reinforcement group, either because they did not pull more than once per light, because they persisted in pulling between lights, or both. The number of subjects eliminated was due, in our best judgment, to the failure of the experimenter to repeat the instructions and demonstrations during the preliminary training. In a second experiment (15), the instructions and demonstrations were repeated until each subject met the necessary criteria and no subject was eliminated. As soon as *S* had met the criteria for the preliminary training, *E* stopped the apparatus and set the stepping relay for the starting position in preparation for the reinforcement training.

Reinforcement Training

E returned *S* to his stand before the apparatus, informed him that he was going to the next room to start the apparatus, and that *S* would be told when he had obtained enough marbles to buy his toy. *E* next returned to the observation booth and started the apparatus. The reinforcement stimulus series was like that for the preliminary training, except that *S*s in Group 12 were given 12 presentations of the training stimulus while those in Group 24 were given 24 presentations. *E* recorded on prepared sheets the number of responses *S* made to each stimulus presentation.

Generalization Test

Following the last trial on the reinforcement training, *E* turned the selector switch so that the generalization stimulus series was presented. The time between the last reinforcement trial and the first generalization trial was nine seconds. The longer interval was necessary due to the extra contact point on the stepping relay. The generalization series was introduced with no other changes in the procedure.

The series consisted of 24 stimulus presentations. Beginning with the first, the training stimulus was strictly alternated with a test stimulus. Thus, there were four cycles, each cycle consisting of three presentations of the training stimulus and one presentation of each of the test stimuli. Three generalization series were used and they differed only in the order in which the test stimuli were presented. Considering the three series to-

gether, each test stimulus appeared equally often in each temporal position. The number of pulls was recorded for each presentation.

Results

An analysis was made of the mean number of responses per trial for the 12 trials of Group 12 and the last 12 trials of Group 24 during the reinforcement training. The mean for Group 12 was 4.32 and, for Group 24, it was 4.97. The difference between these means was nonsignificant ($p > .50$). Thus, the additional 12 reinforced trials given Group 24 did not significantly increase its rate of responding over that for Group 12.

The major analysis of the data involved the number of responses on each presentation of a test stimulus. The data were analyzed by means of an extension of Lindquist's (9) Type VI analysis of variance. The four main factors were the number of reinforcements during training, the stimulus order during the generalization tests, the cycles of the generalization stimulus series, and the different test stimuli.

Table 1 gives the means for Groups 12 and 24 for each stimulus presentation. Since the order of presenting the test stimuli proved nonsignificant,

Table 1

MEAN NUMBER OF RESPONSES TO EACH PRESENTATION OF THE TEST STIMULI

Cycle No.	*Test Stimulus*	*Group 12*	*Group 24*	*Combined Groups*
I	1	1.61	2.33	1.92
	2	1.78	2.39	2.08
	3	1.28	2.50	1.89
	Mean	1.56	2.41	1.98
II	1	1.11	2.56	1.83
	2	1.17	2.33	1.75
	3	1.06	1.83	1.44
	Mean	1.11	2.24	1.68
III	1	0.89	2.44	1.67
	2	0.83	1.56	1.19
	3	1.22	1.39	1.30
	Mean	0.98	1.80	1.39
IV	1	0.44	1.67	1.06
	2	0.39	1.22	0.80
	3	0.39	1.44	0.92
	Mean	0.41	1.44	0.91
Total (All Cycles)	1	1.01	2.25	1.63
	2	1.04	1.87	1.46
	3	0.99	1.79	1.39
	Mean	1.01	1.97	1.49

the data in Table 1 are not broken down according to order. In Table 2 is presented an abbreviated summary of the analysis of variance. Only the main effects are presented, since none of the interactions prove significant at less than the 10 per cent level. The highly significant main effect for cycles indicates that the number of responses made to the test stimuli decreased as a function of the number of previous test stimuli presented. The significant main effect of reinforcement ($p < .01$) reflects the greater number of responses made by Group 24 as compared to those made by Group 12. The differences among the means of the number of responses to the different test stimuli proved significant only at the 20 per cent level.

TABLE 2

ABBREVIATED SUMMARY OF ANALYSIS OF VARIANCE OF RESPONSES TO TEST STIMULI

Source	*df*	*Mean Square*	*F*	*p*
Subjects	35			
Reinforcement	1	99.19	7.97	.01
Order	2	34.42	2.77	.10
error (b)	30	12.44		
Within Subjects	396			
Cycles	3	21.76	16.12	.001
Stimuli	2	2.26	1.67	.20
error (w)	330	1.35		

NOTE.—All interactions have been omitted from the table since none was significant at less than the .10 level of confidence.

DISCUSSION

The results indicate that there is a relationship between the strength of a habit, defined in terms of the number of reinforcement trials, and the strength of the generalized tendency to other stimuli. This relationship is predicted by Hull's (5) and by Spence's (14) theories of generalization, both of which are based primarily on the study of infrahuman behavior in simple conditioning situations. The relationship appears to hold also for preschool children in a relatively complex conditioning situation. This finding is even more interesting in view of the fact that the greater number of reinforcements for Group 24 did not result in a significantly greater number of responses to the training stimulus. Thus, even though responses to the training stimulus did not show the effects of the differential numbers of reinforced trials for the two groups, the differential training was reflected in the number of responses to the test stimuli.

The reduction in the number of responses to the test stimuli as a function of increasing numbers of nonreinforced test presentations is also a

typical finding in generalization studies with both infrahuman and adult human *Ss*. This reduction is presumed to represent increments in inhibitory potential for the generalized S–R connections, and is understood as one of the basic processes of extinction. The very gradual reduction in the response rate for the test stimuli in the present study suggests that the procedures used here may be of considerable value in the study of the variables affecting extinction in children. The very frequently obtained records of sudden extinction were noticeably absent from the present data.

The failure of this experiment to find a generalization gradient among the test stimuli is, perhaps, not surprising considering the fact that no attempt was made to control for the brightness of the stimuli. Thus, the test stimuli differed from each other in terms of at least two physical dimensions—brightness and hue. A subsequent study (15), using essentially the same procedures but with stimuli differing only in brightness, has shown statistically significant gradients of generalization as expected on the basis of behavior theory (5, 14).

The present experiment, then, has confirmed the direct relationship between the number of reinforcements on the conditioned stimulus and the amount of generalization to stimuli similar to the conditioned stimulus. It has also suggested a fruitful method of studying some of the basic phenomena of simple learning in preschool-aged children.

Summary

The present experiment is concerned with the development of a simple learning situation that is suitable for preschool children and in which some of the basic phenomena of stimulus generalization may be studied. Specifically, the hypothesis is tested that there is a direct relationship between the number of reinforcements to a conditioned stimulus and the strength of the tendency to generalize the response to similar stimuli. Thirty-six preschool children were trained to pull a lever repeatedly to a stimulus of a given hue in order to receive marbles. They were then tested on stimuli of different hues to determine the number of responses that would be made to the test stimuli without receiving reinforcement. A group given 24 reinforcements to the conditioned stimulus prior to the generalization test averaged nearly twice as many responses to the test stimuli as did a group given only 12 preliminary reinforcements. It was concluded that the expected relationship was found to hold and that the methods used show considerable promise for the study of generalization phenomena in preschool children.

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INDIVIDUAL PATTERNS OF DEVELOPMENT[1]

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One of the perennial concerns of those who are trying to understand the young human organism is with the evaluation of his present status in the light of his earlier development, and as it bears on his future. We are concerned with the cause-effect relationships between various inherent factors and environmental situations, or between early manifestations and later development. We want to be able to predict, to know *how*, and how early we can tell what a child will turn out to be like.

To do this, we set up norms of development, based on the central tendencies and variabilities of healthy children. In applying to these norms the repeated measures of children over time, we have become increasingly aware that the growth of individuals is often unstable. In a given character, such as height, or intelligence, a child may, over a period of years, shift from high to average, to low and back to average again, as compared with his age peers. The very frequency of these shifts leads us to assume that, for the most part, they are normal and healthy patterns of growth. But we should like to understand the reasons for them, in order to insure optimal development. If we can find some condition that is operating to enhance or lower a child's efficiency or to stimulate or hinder growth, then there is the possibility of doing something to control it. But the processes of growth are very complex: it is often difficult to find a plausible event that could make the difference in the developmental trend. Furthermore, such an event may seem relevant for one child, but may make little difference in other children.

In our longitudinal studies, where we have made repeated observations on the same children over time, and charted the development of each child in relation to the norms, we find that individual patterns are the rule. It is a rare child who follows the same course in all of the observed variables through all of his growth. To explain these individual patterns, we are repeatedly being forced to re-examine the nature of development, and to reconsider the relevant conditions that can determine the course of growth in an individual organism.

If we begin by considering the early stages of the embryo and fetus, it becomes evident that the organism does not start with the discrete structures and functions that we are able to observe and classify later on in child-

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[1] Presented as presidential address to Division 7, Developmental Psychology, American Psychological Association, New York, September, 1954.

[2] National Institutes of Health, Public Health Service, Department of Health, Education and Welfare. (Formerly at the University of California)

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hood. Starting with the relatively simple fertilized ovum, there is, with development, a progressive differentiation of both structures and functions, with a corresponding trend in each toward independence from the others. However, this independence is never complete in the living organism, and there are gradations of degree of independency that are correlated with the amount of similarity or difference between the two factors being compared. Thus the first reflex occurs in the embryo only after a given structural differentiation has been attained. In the neonate the observable behaviors are almost exclusively reflex in nature, and for much of the first year mental development is difficult to distinguish, first from reflex responses, and then from motor coordinations. This very condition forces on us the awareness that there is continuous change in both structural and functional organization in early development. It seems reasonable to assume that as long as there is growth or developmental change in an organism there will continue to be changes in organization; that is, the relative contribution of different factors to any "whole" structure or function will shift as each factor develops, matures and declines.

An adequate frame of reference for understanding change, or differentiation and growth, must include individual differences in temporal processes, as well as structural and functional processes. That is, not only do structure and function develop and become differentiated from each other, but also they do this at different rates. These differences in timing occur for different aspects of a single organism, as well as between different organisms.

Consequently, in studying individual patterns of growth we must take all of these dimensions of change into account. They all are important both in the predictions of a child's future development and in the evaluations of his current status. Only when we understand the regular processes of changing organization will we be able adequately to assess the relative importance of specific environmental variables in altering the processes of development in an individual.

The Study of Patterns of Development

When we have a series of measures and observations on a child over time, as he grows from infancy to adulthood, there are several ways in which we can orient the data, in order to study his patterns of development.

Normative Age Curves of Growth

The usual way to present growth, or change, over time is to compare a child, at successive ages, with values that have been obtained for other (presumably normal) children the same ages. This may be done by presenting individual curves of growth which show the child's scores in rela-

tion to some measures of central tendency and variation. Sometimes the normative frames of reference are curves representing the means and intervals of one standard deviation from the mean. Sometimes series of percentile curves are used such as the 10th, 25th, 50th, 75th and 90th percentiles.

In either of these methods of establishing norms the data are grouped on the basis of chronological age. That is, a child is compared with other children the *same age*. It is sometimes possible, however, to set up norms on groups that are homogeneous in other respects. For example, one could group together measurements of children who are at the same stages of maturity in that factor which is being measured. Thus children of the same skeletal age may be grouped together, as being equally mature physically. Such standards are useful in determining whether a child is developing normally for his own time schedule in that and related characteristics, regardless of his calendar age.

When we have longitudinal data on the same individuals over long periods of time, there is another method of expressing growth that has been found very informative. The child's own status at some stable or well-defined period can be made the standard against which his status at other times can be compared. For example, his height at closure of epiphyses in the bones of the hand, or his intelligence score at 21 years, can be taken as the point of reference. If we call this point 100 per cent, then the fraction of that figure can be computed for the relevant measures taken at all other ages. This procedure has the advantage of eliminating individual differences in size or in capacities. It thus makes more clear-cut the study of time patterns, or growth rates, within the individual. These time patterns can then be compared for a normal sample, to learn the normal variations in prococity or retardation, or lability of the factor under consideration.

Relative Scores and Increment Scores

The methods described so far are applied to total scores or measurements in individual functions or structures. Relative scores or increment scores can be applied to any of these general methods. Customarily, relative scores are expressed by comparison with the average at a given chronological age, as standard scores or quotients (e.g., IQ or DQ). They could, however, be related to skeletal age or some other standard of maturational status. Age curves of such indices are often charted to show stability or change in relative status over time. They do not indicate growth directly: thus the constant IQ when charted by age is represented as a straight horizontal line, regardless of increasing ability. A continuously dropping standard score may, for example, be consistent with steady slow growth in actual ability.

Where growth is more rapid at some ages than at others, the pattern of change is often charted as a series of increments, or rates of change. For example, annual increments in height have characteristic changes in rates of growth, with periods of rapid growth in infancy and again at adolescence.

All of these methods yield information that is useful in evaluating a child and the course of his growth, but each is limited, and each supplements the other. Some methods are more practical, and more readily put to use. Others, more difficult, may serve their purpose if they only indicate the allowances that must be made in the interpretation of data presented in the more customary way.

The Problem of Comparability of Units of Measurement

When we wish to study the over-all development of a child, the charting of growth curves presents another problem, that of setting up comparable units of measurement for the purpose of comparing different kinds of data. We would like to compare centimeters with kilograms, and, what is far more difficult, compare absolute measurements such as centimeters and kilograms with imprecise units such as increments in intellectual ability or changing patterns of skeletal ossification. Usually these latter have been derived from observations on normal samples, reduced to the amount of change to be expected from one age to another, and expressed as mental age or skeletal age and the like. Such age norms do not take into account the facts that growth is not usually equal in intensity or extent at all ages, nor are the standard deviations of the different types of test equal or alike in their growth trends. Thus, conversion of scores into "ages" tends to minimize some evident differences in rates of development, and to exaggerate others. In the field of intelligence testing this has been considered a very real problem, and various attempts have been made to set up "absolute" scales of mental units. Such absolute scales are usually derived by comparisons of overlapping distributions of scores at successive ages, taking into account both increments with age, and standard deviations. These scores are not really absolute, but they are useful approaches in this direction.

Factors and Proportions

The proportionate contributions of various substructures or part-functions to the whole may be expressed by ratios, or other statistical devices. For example, in anthropometrics we can describe varieties of body build by relating several measures to stature: the ratio, stem length/height, differentiates between the long-bodied and the long-legged; bi-iliac diameter/height is used to separate the slender from the broad-built; weight/height also differentiates between relative stockiness and linearity of build. Statistical methods, such as covariance and factor analysis, are applied to anthropometric values and to behavior data, to show the relative contributions of several sub-scores to a total measure of physique, intelligence, or personality, and the like. All of these devices can be applied to the study of age changes in individuals by securing repeated values at successive ages wherever the relevant measures are available on the same subjects, as in longitudinal studies.

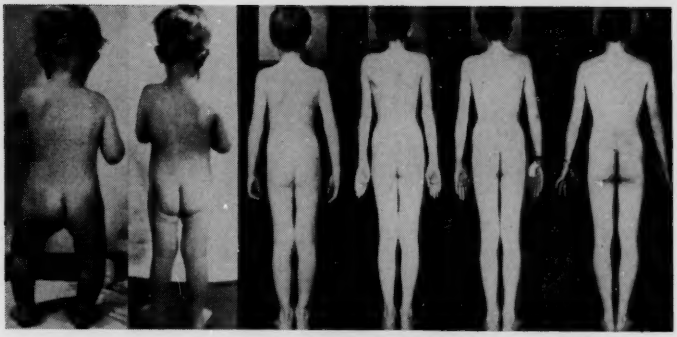

FIGURE 2—Changes in body proportions with growth, shown with photographs of the same boy at six ages, all adjusted to the same height.

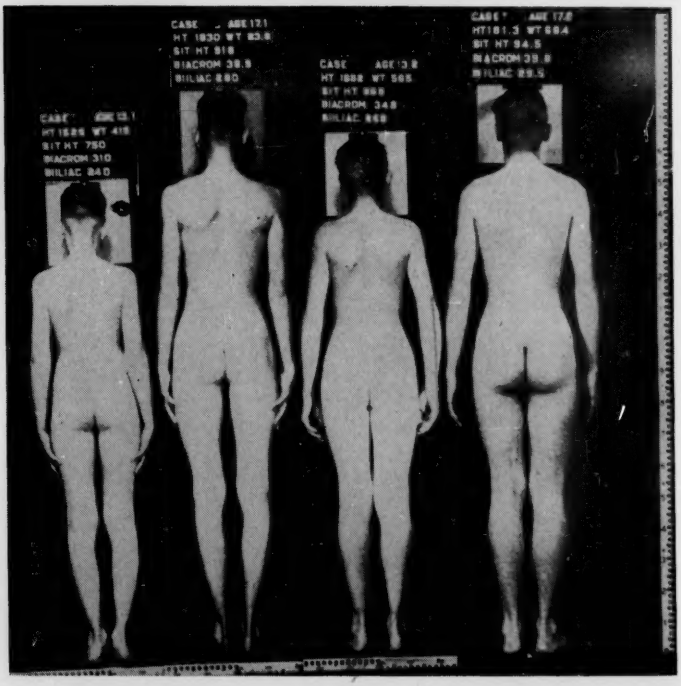

FIGURE 5—Comparison of two boys who differ in skeletal maturity. The retarded boy is slender-built and relatively much shorter at 13 years than is the husky accelerated boy. From Bayley (2).

Data from the Berkeley Growth Study

I should like now to illustrate some of these methods as applied to the Berkeley Growth Study (12) data, showing their values and limitations. In the process, I hope to show, in patterns of individual development, the nature of interrelationships between several different aspects of mental and physical development from birth to young adulthood, as they are found in this small normal sample. The subjects of the Berkeley Growth Study were originally selected as normal infants when first seen in the hospital during their first few days of life. Forty of these children have continued in the study and have been tested through at least 18 and some through 25 years.

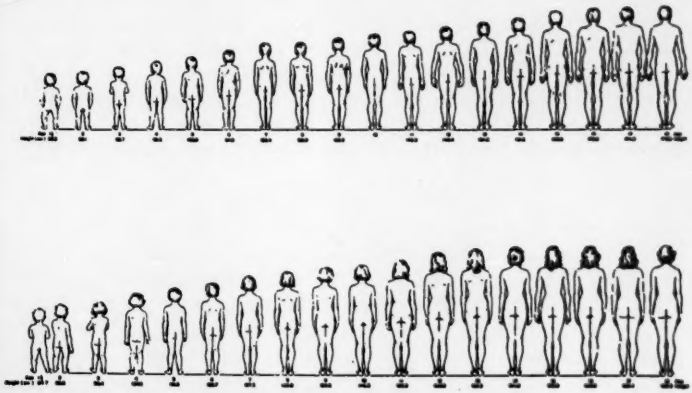

Figure 1—Growth of one boy and one girl from 15 months to 18 years. From the Berkeley Growth Study.

Patterns of Physical Growth

Let us start with some aspects of the actual appearance of the normal child as he grows up. In Figure 1 we have a form of growth curve of one boy and one girl from 15 months to 18 years. These are tracings from photographs, drawn to scale and spaced so that growth in size is represented at annual intervals. We see that the girl gets her height sooner, but the boy is eventually taller. Over most of this period the legs are growing faster than the stem. With maturing of the body at adolescence the girl's hips and the boy's shoulders broaden. The changes in relative proportions become more evident in Figure 2, when the photographs of this same boy, at 6 ages (15 and 30 months, 6, 11, 14 and 18 years) are reduced to a constant total height. This in effect is what we do when we compute ratios of stem length or bi-iliac width or weight to stature. The head makes up a steadily dimin-

ishing part of the total; the legs grow relatively longer to 15 years, and then the stem length increases slightly; the whole body is broad at 15 months, then slenders down, to broaden again later, mostly in the shoulder girdle. The same patterns hold for the girl, except that as she approaches maturity, it is her hips rather than her shoulders that become wide.

In Figure 3 the conventional curve of height for age is compared with a proposed new set of curves. This chart is based on data from several longitudinal studies at the Institute of Child Welfare, primarily the Berkeley Growth Study (12) and Macfarlane's Guidance Study (13). The average curve of height for chronological age of these children is represented by the heavy center line, as "smoothed" by the segments of dotted line. Actually children do not grow in height according to such means of height for age. Their growth is more like that of the solid line that changes direction more abruptly. In this chart the solid curves are based on data that are grouped, not by chronological age, but by their degree of physical maturity. Maturity was determined from readings of the X-rays of the bones by standards that are based on per cent of mature height (7). The mean age and height were determined for each successive grade of maturity. The curves on either side of the mean represent the trends of growth of children who are one *SD* or more accelerated (the curve on the left) or retarded (on the right) in their skeletal maturing. The broken lines represent the actual growth of fairly extreme cases of a tall accelerated and a short retarded child. Height curves for individual children tend actually to follow or to parallel one or the other of these lines. Figure 4 gives the same data for girls. It is notable that, except for the extremes, the mature average heights of the three groups maturing at different rates are very similar.

Body build tends to be related to rates of maturing (2). That is, the physically accelerated children are more likely to be broad-built, while the retarded children are more often slender. In Figure 5 we see typical examples of a retarded (left) and an accelerated boy at 13 and at 17 years. At 13 the husky accelerated boy is more nearly his own 17-year height than is the slender retarded boy.

In Figure 6 are shown 3 girls at maturity. They had different patterns of growth: "A" matured early, "B" was slow in attaining her final height, "C" had a very atypical rate of maturing. Their growth curves by age are shown in the left hand side of Figure 7. Slow-maturing B grew tallest, but she was relatively short before 12 years. On the right are the 3 curves of skeletal ages, as read on the Todd standards. Girl C was very accelerated from 8 to 11 years, then matured very slowly until at 13 years she fell in line with the average and maintained this status. Figure 8 gives on the left the curves for these same three girls, each in relation to herself. In attaining their own adult heights, A was advanced and B retarded, while C grew atypically. On the right are the curves of their skeletal maturity, as read on our XM standards (7) that were derived from per cent of mature height

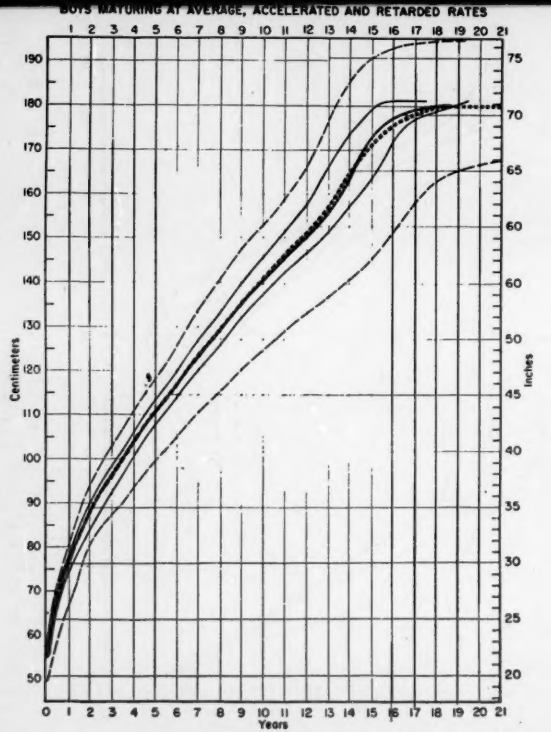

FIGURE 3—Growth curves of boys' heights, showing the difference between the conventional method of mean height for chronological age (dotted line) and height for age in groups that are equated for physical maturity.

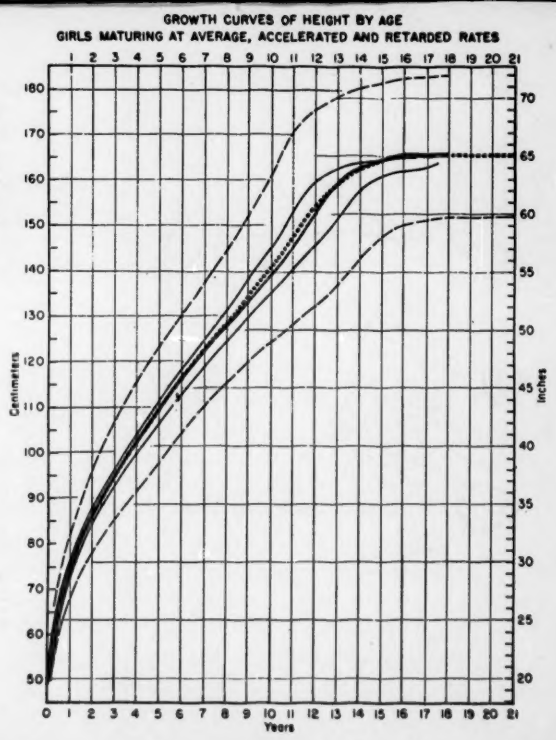

FIGURE 4—Growth curves of girls' heights, showing the difference between the conventional method of mean height for chronological age (dotted line) and height for age in groups that are equated for physical maturity.

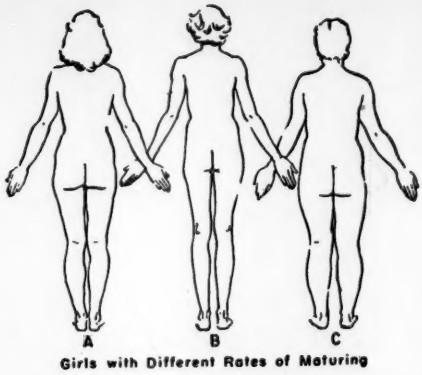

FIGURE 6—Three girls, at 18 years, who matured differently. A was accelerated; B was retarded; C's growth was irregular.

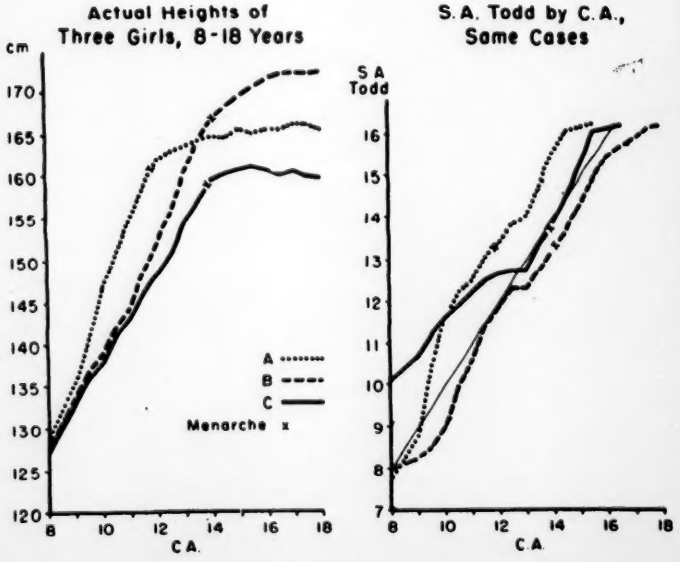

FIGURE 7—Curves of height and skeletal age of girls A, B, and C. Age at menarche for each is indicated by an *x*.

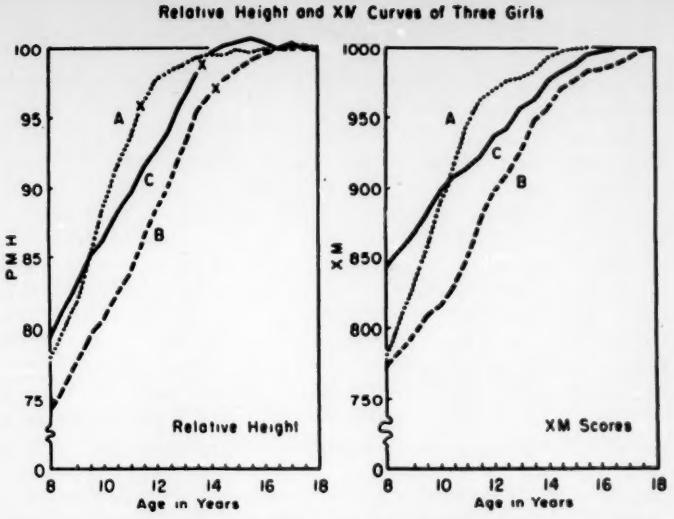

FIGURE 8—Growth curves of girls A, B, and C, showing on the left the per cent achieved by each girl of her own adult stature, for ages 8 to 18; and on the right degrees of skeletal maturity expressed in terms of per cent of mature stature.

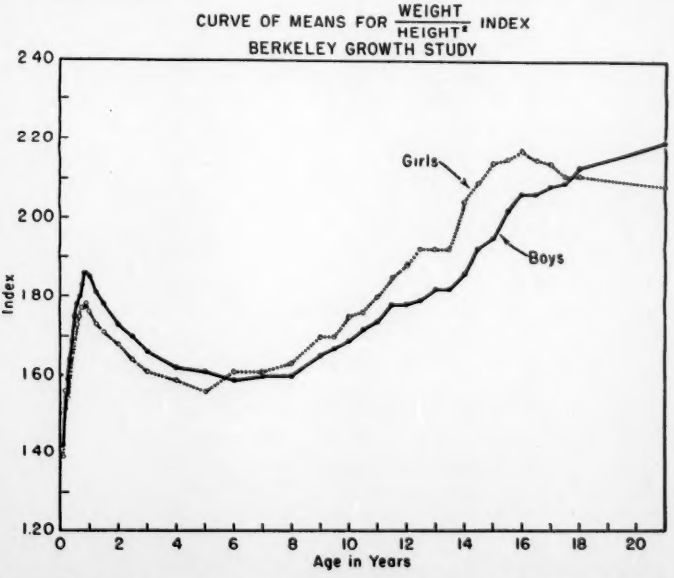

FIGURE 9—Age curves of body build, as expressed by the index W/H^2, for boys and for girls.

groupings. According to these curves, we see that each girl's growth is closely related to her skeletal maturing.

We have seen in the first three figures that body proportions change with growth. These changes in proportion are well represented by the age curve of the index W/H^2, as given in Figure 9 for the Berkeley Growth Study boys and girls. Proportionate to his length, the newborn infant is very slender (except for his head). He soon broadens out in all other transverse dimensions, and this trend is reflected in rapid gains in weight during the first 11 months (8). After one year a child usually slenders down to 7 or 8 years, and then broadens out again with approaching pubescence. After 16 the girls' indices drop somewhat; evidently they are losing some fat. The boys continue to gain; their "filling out" process seems to be general, including further muscular development as well as some gains in fat.

It has become evident, from these and other data on individual growth, that efforts to classify children into somatotypes, or other classes of body build, must take into account the age, or stage of their maturity. If constitutional types as exemplified in this ratio of build are stable, then we should expect the early-maturers to go through the cycles more rapidly, and the late-maturers more slowly than the average. To test this hypothesis we plotted the individual curves of the W/H^2 index for all of the Berkeley Growth Study cases. Some examples are shown in Figures 10 through 15. First is a boy who is accelerated in skeletal age. He fits the picture of a heavy-set boy who has a short period of relative slenderness. Figure 11 shows a retarded boy who is slow to gain weight. Next, in Figure 12, is an accelerated boy who was obese as an infant, and fat again later around 13 years. But we also find frequent shifts in build, such as in Figure 13. This boy was very heavy-set as an infant, but turned into a slow-maturing, tall rather slender adult. In Figure 14 is a typically heavy, accelerated girl, who contrasts startlingly with her slender, somewhat slower-maturing twin sister, as seen in Figure 15.

There is evidence from other anthropometric ratios and from series of photographs that some children's builds definitely change in some respects. Such changes seem reasonable when we consider the factors that control growth. Goldberg, an endocrinologist, has pointed out (11) that, from conception to about 2 or 3 years of age, growth is determined by the genes, which set the basic pattern. Then the anterior pituitary growth factor, in conjunction with thyroxin, becomes influential in determining growth during the childhood years. This period is essentially one of elongation of the long bones. Between the ages of 8 and 11 the pituitary gonadotropins begin to function more actively, and as androgens and estrogens appear in quantity, rapid growth is initiated. At the same time general physical maturation occurs together with sexual differentiation in physique. These three different and successively dominating controls of growth are somewhat independent of each other. They may vary both in their intensity

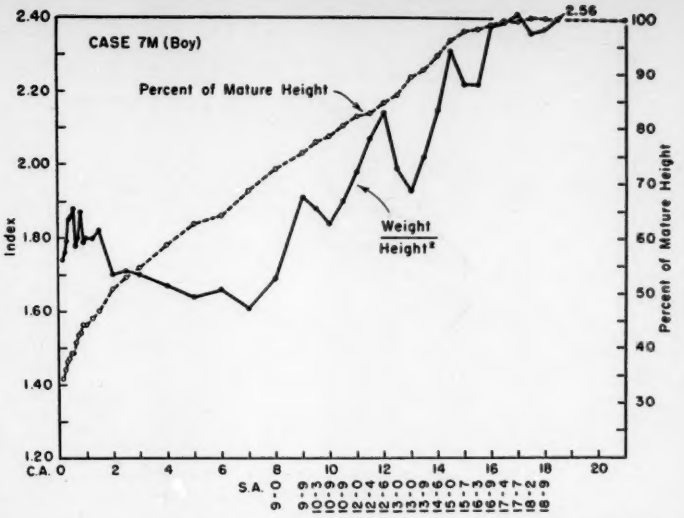

FIGURE 10—Individual age curves of body build and per cent of mature height of Case 7M, an early-maturing boy. In this and Figures 11 through 15, skeletal ages are also given below the corresponding chronological ages.

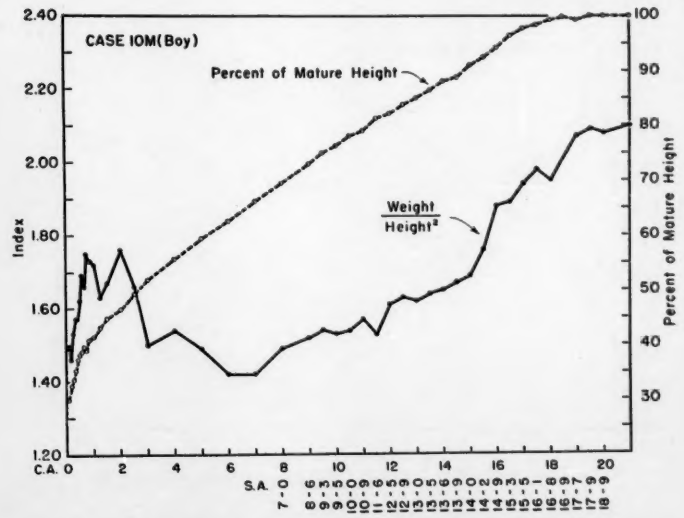

FIGURE 11—Individual age curves of body build and per cent of mature height of Case 10M, a slow-maturing boy.

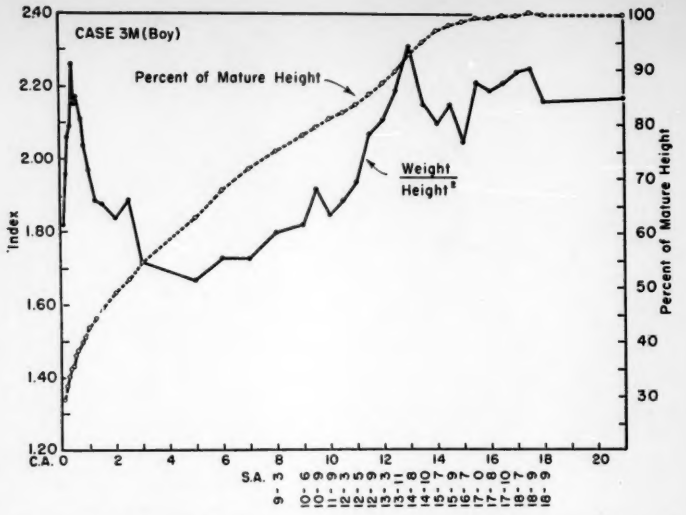

FIGURE 12—Individual age curves of a skeletally accelerated boy who had periods of exceptional weight (fat).

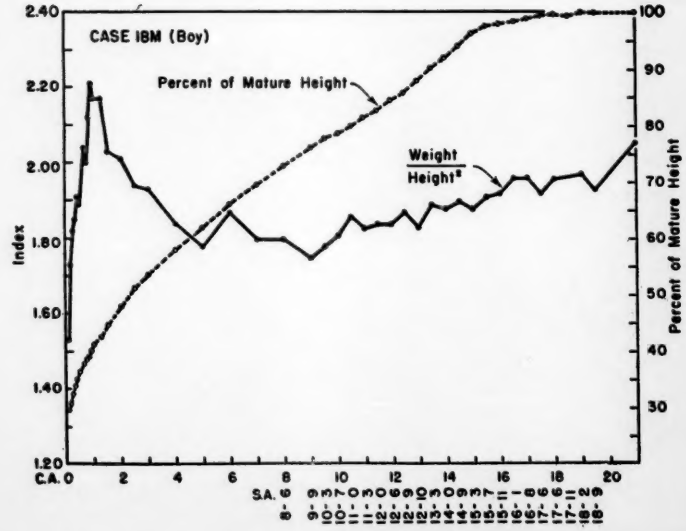

FIGURE 13—Age curves of Case 18M, a boy whose build changed from that of a heavy, stocky infant, to a tall slender adolescent and adult.

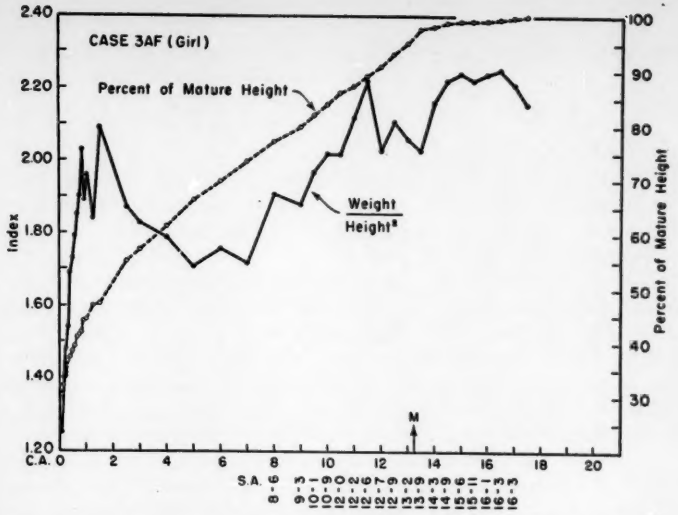

FIGURE 14—Age curves of build and per cent of mature height of an early-maturing twin (Case 3AF) who is relatively plump.

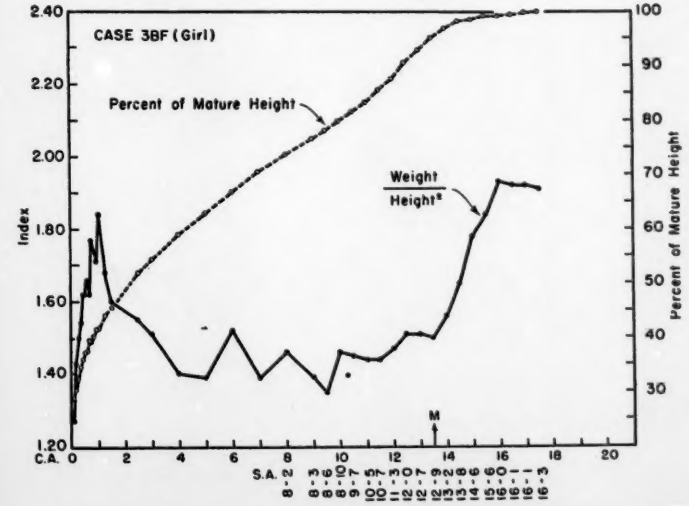

FIGURE 15—Age curves of build and per cent of mature height of 3AF's slower-maturing twin sister, who remained very slender.

and in their temporal patterns. Therefore, at the points of change in their relative influence, certain changes in characteristic growth and build may very well take place.

Age Units of Development

So far, we have been considering physical growth and maturing. Can we present the developmental aspects of behavior and intellectual functioning in ways that will be comparable, and will make possible the evaluation of mental-physical relations in development?

One method that has been used frequently is to convert all of the varibles into age units. Olson (14) has probably developed this method most thoroughly. He has assembled age norms for a variety of physical and behavioral data. From these norms, curves of mental age, height age, weight age, dental age, skeletal age, and the like, are drawn for a single child on one chart. Examples are shown in Figure 16, for years 3 to 14, of a pair of fraternal twins in the Berkeley Growth Study. These curves were prepared by Miss Lois Schulz, using Olson's norms for all pertinent data available in our records. It is interesting to compare the similarities and the differences between Twins A and B. One is more generally advanced, the other more nearly at age in most respects. Twin A is heavy-set, accel-

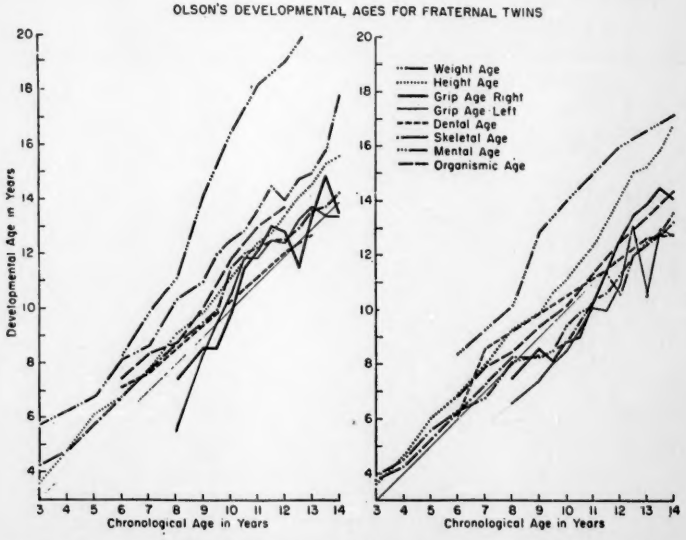

FIGURE 16—Developmental age curves (Olson's method) for 8 variables of twins 3AF and 3BF.

erated in skeletal age, and markedly accelerated in mental age. After 8 years, Twin B is slender, about average in skeletal age, and generally less spread out in the different age curves. The Organismic Age that Olson has suggested is a composite of all the "ages" employed, and is intended to show whether a child is growing, in general, at an average, accelerated or retarded rate. There are, however, limitations to the usefulness of Organismic Age curves. In the first place, if one looks over a number of such charts, it becomes evident that there is great individuality in the patterns of growth, with considerable independence among the different "ages." For this reason it seems unwise to lump them together into a single Organismic Age. We may, on the other hand, learn quite a bit from studying the spread of a child's different age curves, to see where he is more likely to have trouble as a deviant, and to consider how best he can be helped to fit into a group of his age peers.

But, in the second place, we have no assurance that being advanced or retarded by a year in skeletal age means the same thing as a year's deviation in mental age. If the standard deviations of developmental age for the different variables are not similar, then the direct comparison of "ages" is misleading. Furthermore, one cannot tell whether a child is (say) advanced in weight age because he is naturally large, or because he is accelerated skeletally, or because he is obese. By some study, and comparisons of the child's differences in weight age, height age, and skeletal age, the reasons for the deviations may be deduced. But to do this requires considerable understanding of the factors involved, and they may often be overlooked.

The Quotient and the Standard Score as Measures of Relative Status

If we give up age units of growth, and turn to indices of relative status for successive ages, there are two methods that have been used: the ratio or quotient of a given developmental "age" to chronological age (of which the IQ is the best known and most used) and the standard score (or sigma score) based on the means and *SD*s of the normative sample at successive ages. The use of the ratio or quotient has the same limitations as the developmental ages on which it is based. That is, unless all of the age variables under consideration have the same standard deviation the quotients will not be comparable. Furthermore, all of the *SD*s must increase in the same constant way in order to maintain constant quotients for all ages. This is, however, not the case (4). Both mental and physical measurements, while showing increasing variability with age, generally, have periods in which the *SD*s are expanded and then contracted again.

It would seem that the way out of the dilemma is to use standard scores. In most respects, standard scores avoid the faults of the age quotient. In Figure 17, for example, are curves showing the relative mental scores of one girl from one month to 17 years (4). The solid line gives her standard scores for the Berkeley Growth Study norms; the broken line gives her IQs.

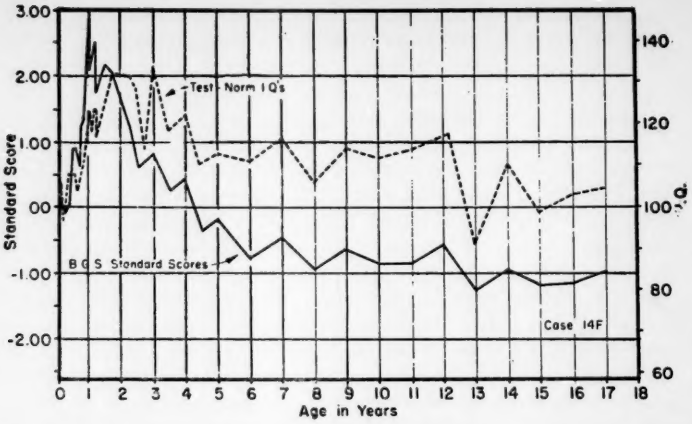

FIGURE 17—Intelligence score curves of Case 14F, expressed as IQs (broken line) and as standard scores according to the Berkeley Growth Study norms. From Bayley (4).

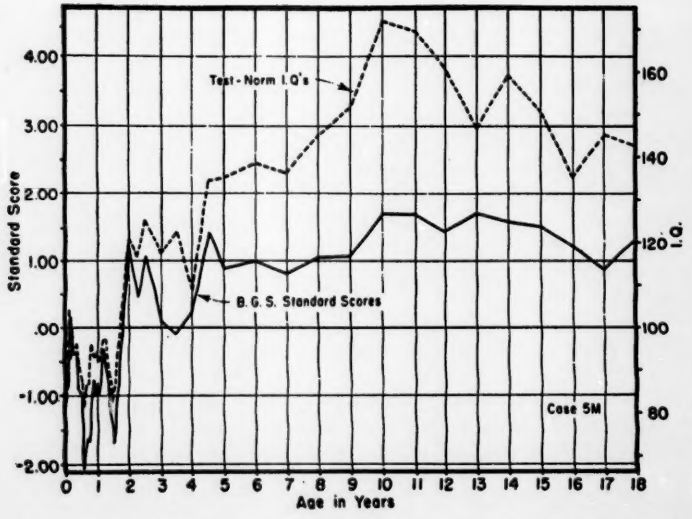

FIGURE 18—Intelligence score curves of Case 5M, expressed as IQs and as standard scores. From Bayley (4).

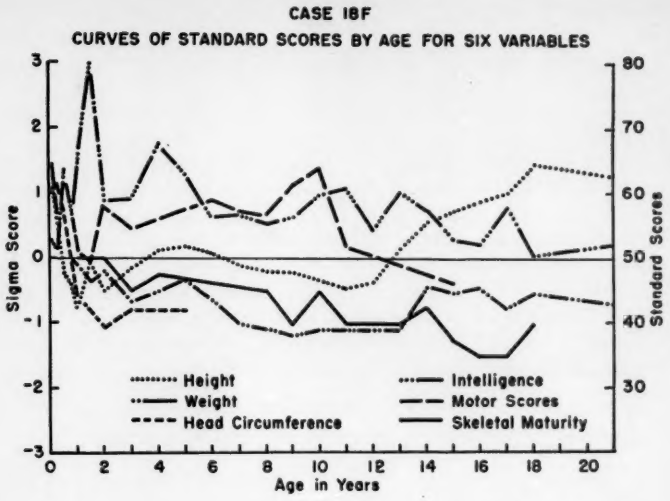

FIGURE 19—Curves of standard scores by age for six variables, for Case 18F.

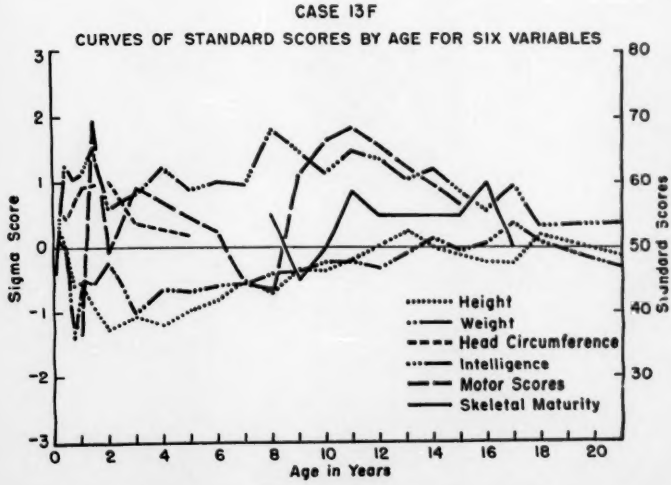

FIGURE 20—Curves of standard scores by age for six variables, for Case 13F.

At 12 months she was the brightest child in the study, and her standard scores at this period are higher than her IQs. This is because the variability in scores in the group was very small around one year. Figure 18 gives the IQ and standard score curves for a boy, whose IQ rose to a very high point at 10 years (4). His standard scores after 4 years are far more stable than his IQs.

From our growth records, we have computed standard scores for several different behavioral and physical measures. Among these are height, weight, head circumference, skeletal maturity, mental and motor development. Standard score patterns for six variables on one girl are shown in Figure 19. A detailed reading of the chart shows that this girl was small and slender, with a small head; she matured slowly and became a tall slender adult; she was consistently superior in intelligence, but more so at some ages than at others; her scores in motor tests varied between superior and average. Around one year of age, when her intelligence score was highest,

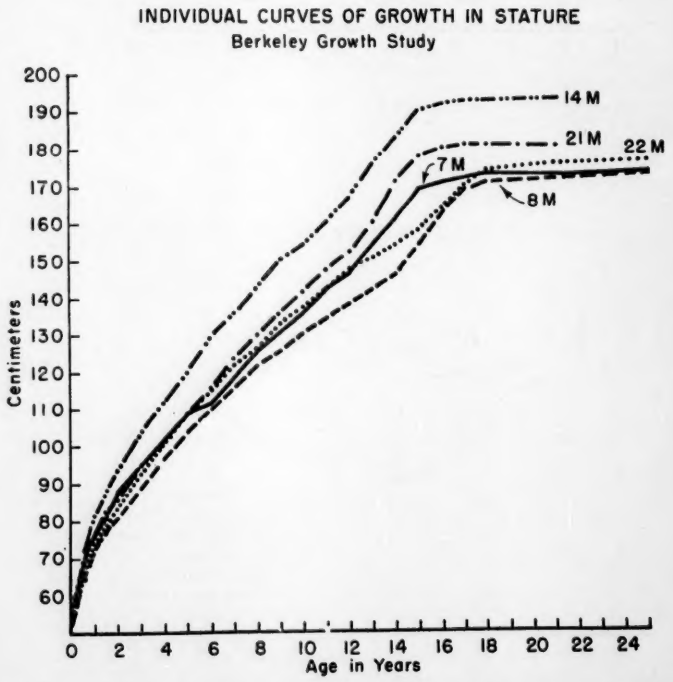

FIGURE 21—Curves of stature by age for five boys in the Berkeley Growth Study.

her pattern of motor scores appears to be almost exactly reversed. In Figure 20, case 13F presents a different pattern, with a tendency for all scores to converge toward the average as she approaches maturity. If space permitted, other cases, with equally diversified curves, could be shown.

Again, as was seen in the Olson method of Developmental Ages, these individual cases display great independence in the patterns of growth of the different variables. In some instances there appears to be concomitant variation between those variables that are highly intercorrelated, such as height and weight. Also, there is evidence that certain ones, such as mental and motor development, become more independent of each other with age.

There is one serious drawback in the use of standard scores for curves of this kind, as applied to the first year or two of life. As you may have noticed from the foregoing illustrations, the variation in standard scores during the early years is exaggerated. Because the spread of scores at these ages is actually very small as compared with the later ages, a difference of a few centimeters, or of one or two items in the mental test, can mean a

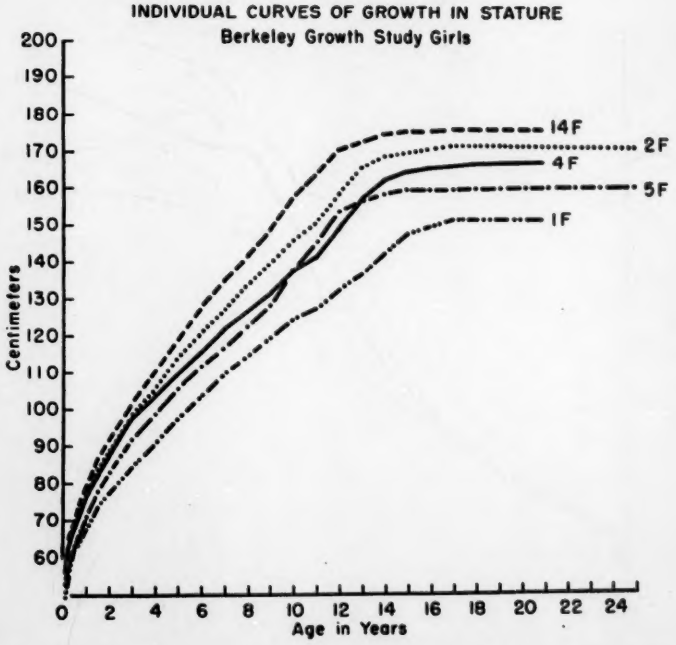

FIGURE 22—Curves of stature by age for five girls in the Berkeley Growth Study.

difference of half a standard deviation or more. In comparison with the early rapid growth, individual differences at a given age are small, and the infant's growth is much more stable than these wide swings in standard scores would imply.

Absolute Units of Growth

The relative importance of absolute units in evaluating growth and change may be seen in the next series of illustrations. Figure 21 shows the curves for height of five boys, who were selected from the Berkeley Growth Study as the tallest and shortest, at maturity, together with three of intermediate height. The heights of all five are very similar at first, as compared with later ages. Note, also, that there is some crossing of the curves later, because of differences in rates of maturing. Each individual curve is very stable, following a definite pattern. But differences in rates of maturing can make a child's standard score for height shift up and down considerably

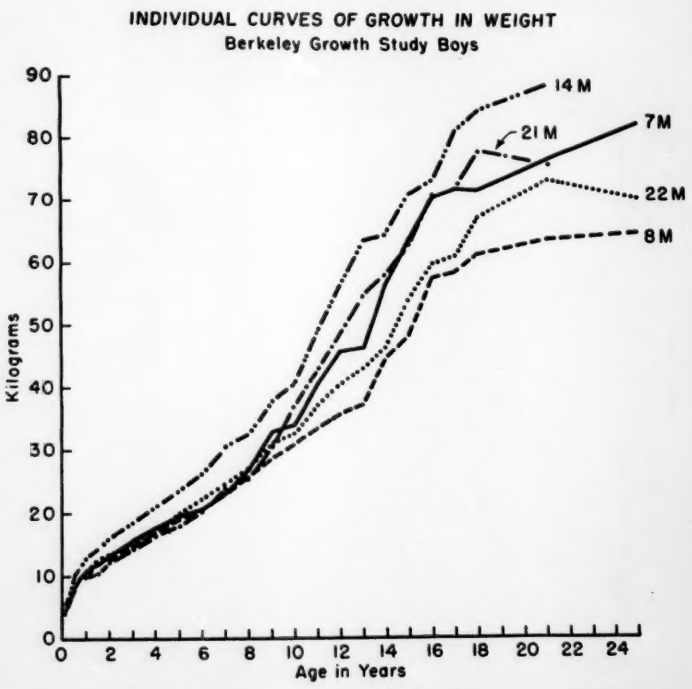

FIGURE 23—Curves of weight by age for the same 5 boys shown in Figure 21.

during the period of puberal growth. Figure 22 shows similar data for five girls.

Changing to another variable, Figure 23 presents the curves for the same 5 boys of weight for age. Again we see that at first the differences in weights are very small. The curves for weight are much less regular than for height: Weight is far more subject to short-term influences, of variations in health, nutrition and the like, than is height. In Figure 24, giving weights for the 5 girls, this instability is even more evident, and notably in the larger, heavier girls. Some of them become quite fat, and then reduce.

What about intelligence? Can we show whether or not it presents a similar trend toward increasing diversity with growth? Here we are confronted with the problem of setting up comparable units of increment for intelligence. There is ample evidence that mental ages in normal samples tend to become more variable with age. In working with the Berkeley Growth Study scores on intelligence tests the problem was further complicated by the need to compare scores from several different tests, having different methods of scoring. This has been done by the device of relating all scores to the mean and *SD* earned by this group on the Wechsler-Bellevue

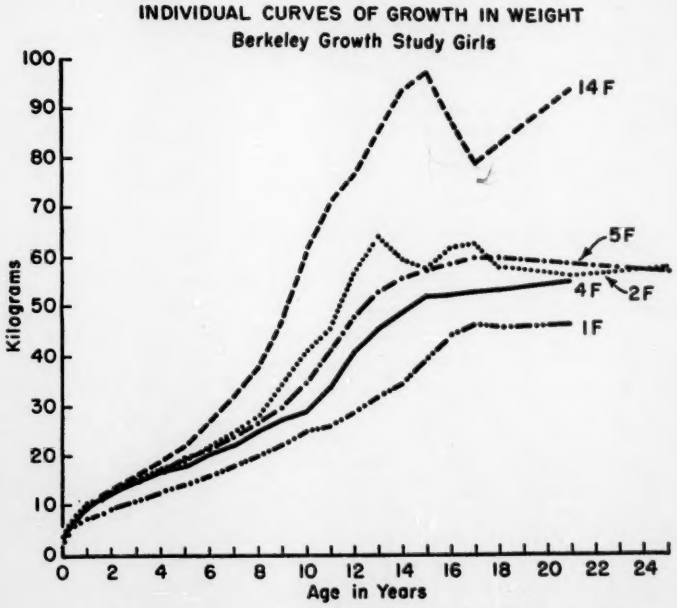

FIGURE 24—Curves of weight by age for the same 5 girls shown in Figure 22.

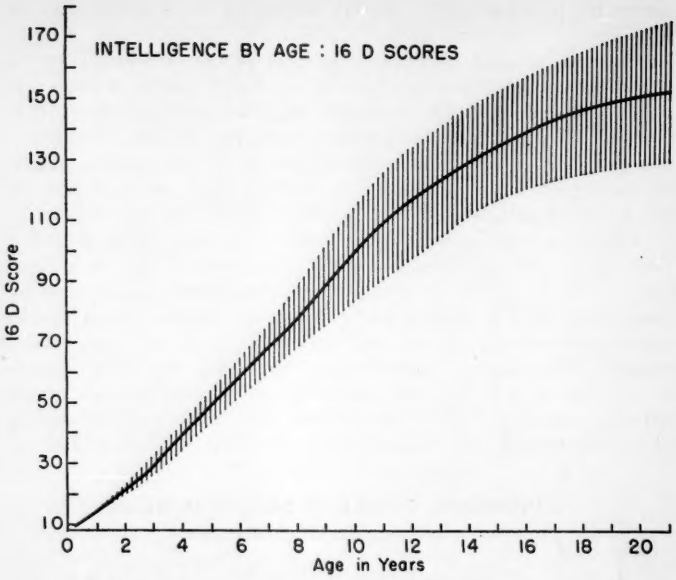

FIGURE 25—Curve showing the mean and *SD* of intelligence scores of the Berkeley Growth Study children from birth to 21 years. Scores from several different tests were converted into units based on the mean and *SD* of the 16-year test scores. From Bayley (6).

scale at 16 years (6). By adjusting the means and *SD*s earned on the Stanford-Binet and the Terman-McNemar tests at adjacent ages, all scores for the three scales and for all ages, were converted into units of deviation from the 16-year mean, in terms of the 16-year *SD*. This has been called tentatively, the 16-D score. Figure 25 gives the means and *SD*s of these 16-D scores from one month to 21 years. They are not "absolute" units, but they do give a general picture of growth relative to the status of this group at 16 years. Again the variability in scores for the first 2 years is very restricted, as compared with the later ages.

In Figure 26 are individual curves for 5 boys selected to represent wide differences in adult intelligence. Note that all five have been tested through 25 years, and in all of them the scores are still increasing. These curves, too, are less regular than the height curves, but perhaps no less regular than the weight curves. One gets the impression both of differences in rates of maturing and of differences in inherent capacity. Superimposed on these general trends are the fluctuations that may be related to differences in motivation or drive, or to other factors such as emotional distractions, or

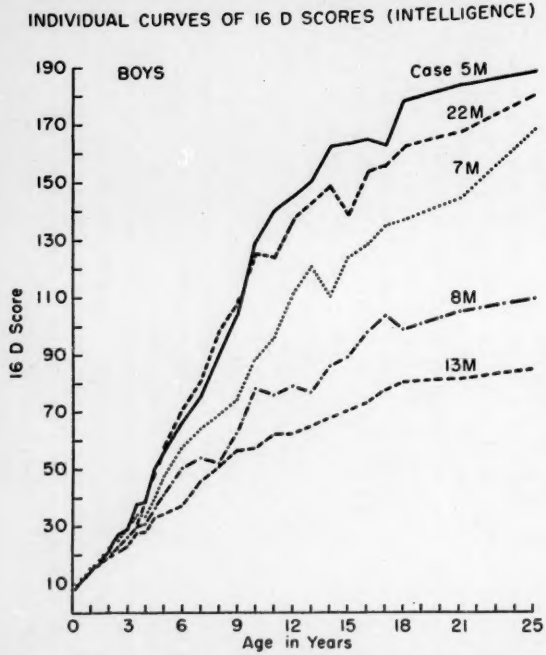

FIGURE 26—Individual curves of intelligence of 5 boys, from 1 month to 25 years. From Bayley (6).

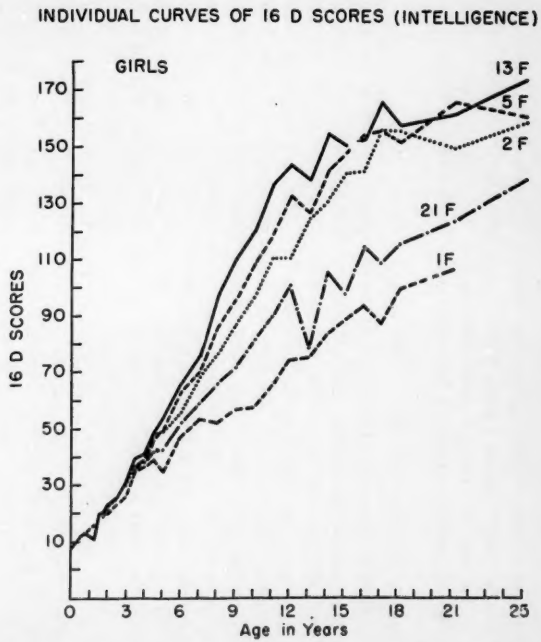

FIGURE 27—Individual curves of intelligence of 5 girls. From Bayley (6).

differences in the content of the tests used at different ages. Figure 27 shows the same thing for 5 girls. When we see how closely alike the scores are in the first two years, it seems obvious that this is at least one reason why it is impossible to predict later intelligence from scores in infancy.

Individual Differences in Rates of Maturing

It must be remembered that some of the changes in patterns of standard scores are due to the fact that children differ in their time schedule in going through the processes of growing up. In Figure 28, for example, are the standard scores for height of three children (5). They are compared with the standard scores of their own parents' height, to show that the children differ in the age at which they come to approximate the parental status. One important reason for the early deviations in growth pattern is that the children are maturing at different rates. The first, 18F, is a slow maturing girl who became tall, like her parents, only after 16 years. The second is a small boy who was like his parents from an early age. The third had very rapid growth, and was accelerated skeletally during childhood. He was tall for his age between 2 and 16 years, when he matured and stopped growing, becoming a just average-height adult. In Figure 29 we see similar variations in patterns of approaching parental status (5). This time the children's intelligence is compared with their parents' education. Possibly these patterns, too, can be explained as inherent differences in rates of intellectual maturing.

Is there some way to control or rule out individual differences in size or ability, and thus simplify the study of differences in rates of growth? As I mentioned earlier, when we have available a series of measures taken during growth, together with a stable measurement at maturity, then that stable measure can be used as a point of reference, against which any child's other measures can be evaluated. For example, we can take each child's height at the time the epiphyses of his long bones fuse and he has practically stopped growing, and call this figure 100 per cent (10). The portion of this stature attained at each earlier measuring can then be computed. In this way all of the children's rates of growth toward their final statures can be compared without the confusing differences in size. Individual curves of per cent of adult height are given in Figure 10 through 15, where they may be related to both the child's chronological age and his skeletal age.

We may try to approximate this condition for the intelligence test scores, but there are several differences between the two. As noted already, the units of intelligence are not directly comparable, and can be considered only as approximations of more and less ability. But there is another difficulty. These children did not conveniently stop improving in their intelligence test scores. Fourteen out of 15 so far tested at 25 years are still gaining. For present purposes, however, it was necessary to choose a point for comparison. Twenty-one years seemed most reasonable, as the age at which recent

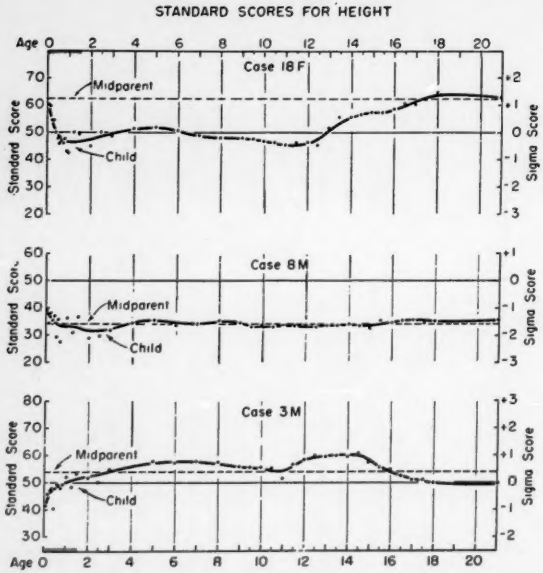

FIGURE 28—Relative heights, by age, of three children, shown in relation to the average relative height of their own parents. From Bayley (5).

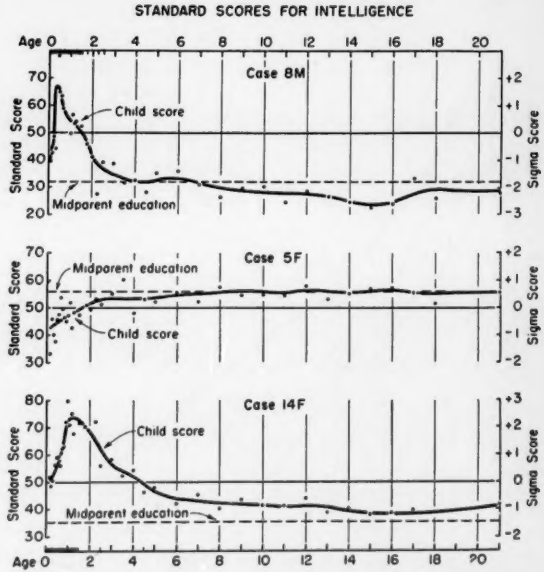

FIGURE 29—Relative intelligence scores, by age, of three children, shown in relation to the relative education of their own parents. From Bayley (5).

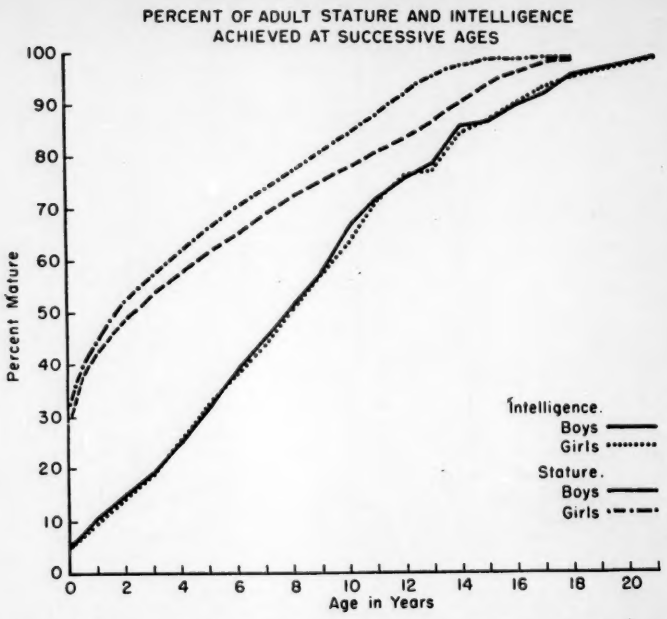

FIGURE 30—A comparison of growth in stature and intelligence, when both are expressed as fractions of mature status.

investigations have usually found the high point in intelligence test scores. Using 21 years, then, as 100 per cent, and the 16-D scores, each child's earlier per cent of adult intelligence was computed. Figure 30 gives the curves of the means for the per cents of adult status for height and for intelligence, and for boys and girls separately of the Berkeley Growth Study Sample. It is evident that growth in the two factors differs in several ways. We find obvious sex differences in one and not in the other. The periods of rapid and slow growth do not coincide, but seem almost to alternate. A study of annual increments indicates that intelligence is accelerating most rapidly up to 5 or 6 years, with another short spurt between 9 and 11. Height, on the other hand, though most rapid during the first 2 years, grows at a declining rate until 8 or 10, with adolescent spurts between 10 and 12 for the girls and 11 and 15 for the boys.

With such independence in the rates of growth in these variables we should not expect to find very closely related mental and physical maturing in the same child. A few correlation coefficients bear on this point. These children's heights and 16-D intelligence scores are positively correlated, as

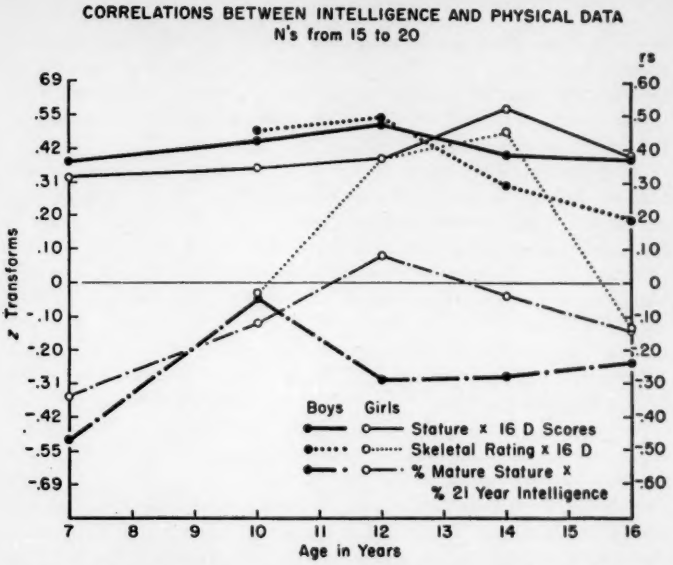

FIGURE 31—Correlations for boys and girls separately, of intelligence scores with stature and skeletal age, and of per cent of 21-year intelligence score with per cent of mature stature.

seen by the *r*s in Figure 31, connected by the solid lines. Actually, the *r*s, which vary around .40, are surprisingly high, when compared with similar correlations reported for other studies. Shown here also, connected by dotted lines, are the correlations between skeletal maturation and the intelligence scores. These *r*s tend to be positive, also, until skeletal maturity is reached.

When, however, we compare the per cent of mature height with per cent of 21-year intelligence scores, as seen in the two lower curves, the picture is very different. These *r*s are not large, but they are, with only one exception, of negative sign. In this small group of children, it seems that the more intelligent children tend to be both larger than average, and accelerated in physical maturing. But within the individual child his own mental and physical rates of growth are not concomitant. If anything, there is a suggestion that those who are slower in physical maturing approach their 21-year intelligence sooner. That is, if we think of it in the more usual way, there may be a tendency for the less able (and these are also, generally the socio-economically less favored children) to be slow in maturing physically. But they attain most of their intellectual growth early, and slow down in

this respect as they approach adulthood. These same children, as I have reported earlier (1), are the ones who in infancy tended to make high scores on the mental tests. That is, the children's mental test scores for the first 6 months correlate negatively with their scores at 3 years or later. There is also a negative correlation between the scores at ages 3 to 7 months with the amount of their parents' education (9).

In this presentation, I have neglected the environmental factors, as they bear on individual patterns in development. Other areas not dealt with are emotions and various aspects of personality, which cannot easily be fitted into development sequences or scales. These factors have been omitted, in part, because it seems to me necessary first to understand the conditions under which they must be evaluated if we are to estimate their effectiveness.

It is evident that the whole process has become very complex. But, keeping in mind as many as possible of the relevant factors just reviewed, we can go down the list of cases, and try to decide which array of factors is pertinent to the course of each child's physical and mental development. Let me list briefly a few examples that will illustrate a few kinds of relationships we have found.

In a pair of fraternal twins, who were born just a little prematurely, there were closely similar patterns of rapid early growth in both size and behavioral functions. At this very early stage, structure and function were not yet independent. However, later, their mental and physical curves became very dissimilar: One twin became heavy, the other remained slender. One twin with real problems of social adjustment made significantly higher scores on the intelligence tests than the better adjusted twin. Possibly the very difficulties of adjustment caused Twin A to turn to intellectual preoccupations as a form of compensation (Cases 3A and 3B in Figures 14, 15, and 16).

A boy who never seemed highly motivated, intellectually, earned fair intelligence scores, but had difficulty graduating from high school. He suddenly evidenced strong motivation on his 25-year test, with a large increase in score. A short time before this last test he had struck out on his own for the first time, on a job that was not connected with the family business, and he was belatedly making good (Case 7M in Figure 26).

A girl made phenomenal intellectual growth between 2 and 10 years. During much of this time she was invalided with asthma. She was strongly competitive with an older sibling, and used her enforced rest periods in reading and imaginative games.

A boy who was very slow in both motor and mental development during infancy made rapid intellectual progress after two years: He was highly verbal, but never gained much skill in his motor coordinations. Here the emerging independence of intellectual capacities seems to have permitted their more rapid growth (Case 5M, Figure 18).

One boy was undernourished in infancy, with accompanying retardation in physical maturing and growth, but this seemed unrelated to his relatively steady mental development.

Several children suddenly slowed down in their skeletal maturing, at around 13 years, with subsequent prolonged slow pre-adolescent growth. Two of these, with their later spurts of growth, eventually attained taller statures than had been predicted before 13. In these cases there appeared to be more or less normal delays in starting the steroid phase of growth.

There was at times evidence that a child was "bored" with repetition of the same old mental tests, and the resulting poor effort lowered the score. An adolescent girl, suddenly aware of her plumpness and more curvaceous figure, would diet and lose weight. And of course, severe illnesses often caused temporary slowing down of the physical growth processes.

There are as many more such examples as there are children in the Study. However, there is not space here for them all or even to go into the details to support these brief descriptive statements. But the data are there, and it can be done. The more one goes over these cases, the more evident it becomes that the pattern of growth in each child is unique. We can compare him with his peers, and with his own past history. Often, after the fact, we can find an explanation of the causes of his deviations, some of which seem to be inherent and some environmental. With the accumulation of this kind of information, we can hope gradually to develop general rules that will permit us to make some evaluations and some tentative predictions, and even, in some instances, to correct undesirable deviations.

I hope these evidences of the complexity in the processes of child development will not be too discouraging. On the contrary, they should spur us on to learn more about their intricate interrelationships. Only in this way may we eventually set up optimal conditions for growth and development.

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EXPERIMENTAL RESEARCH IN CHILD PSYCHOLOGY

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From the literature of child psychology, and from discussions with child psychologists throughout the country, the writers have obtained the definite impression that child psychologists are concerned and somewhat troubled about the present and future status of their field. In particular, two deficiencies in the area appear to be arousing consternation. The first concern has to do with an alleged deficiency in the quality and quantity of research conducted by child psychologists, and the second with an alleged lack of interest in theory on the part of child psychologists. The writers agree that these two deficiencies exist. Rarely, however, have they observed the two discussed in relation to each other. It seems to them that there is actually a close connection between the type of research that has predominated in the field and the failure of theory to develop. It is the purpose of this paper to attempt to show what this connection is.

First, perhaps, a few comments should be made concerning the essential characteristics of scientific theories. A scientific theory consists of (*a*) a set of clearly defined terms that refer to empirical phenomena; (*b*) a set of basic principles (axioms) that relate many of the concepts to each other; and (*c*) a further set of empirical laws that may be deduced, according to the rules of mathematics and/or formal logic, from the basic principles. For the scientist, explanation consists in the deduction of the phenomenon to be explained from the set of basic principles. In this strict interpretation of scientific theory, it is clear that neither child psychology nor general psychology has thus far met with more than moderate success in theory construction.

There are no logical rules to specify what characteristics the axioms of a theory must have, other than that additional laws must be deducible from them. There are, however, some empirical considerations that are suggested

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by examining the histories of other, more mature sciences. For one thing, the axioms of mature scientific theories have contained concepts that refer to basic variables. The discovery of which variables are basic demands that the scientist isolate, in some manner, the independent variable in such a way that he can discover if and how it affects the dependent variable. The usual method of isolating the independent variables is by means of the scientific experiment. The scientist sets up an experiment in which the independent variable is under his control and manipulation. He then systematically varies the independent variable and determines whether or not, and how, it affects the dependent system. It is, of course, not always possible or necessary to manipulate the independent variable experimentally. The most extensive use of a non-manipulative method of isolating the independent variables can be found in classical astronomy, where none of the variables is subject to the scientist's manipulations. It is interesting to note, however, that Newton's theoretical integration of terrestrial and celestial mechanics made extensive use of Galileo's experimental data on falling bodies, and it is improbable that he would have invented his concept of mass if he had not had the Galileo data available.

While a relevant variable can be isolated without the experimenter's having control over it, the difficulty of this procedure is vastly increased as the number of relevant variables affecting the dependent system is increased. That a very large number of variables affects the behavior of the living organism is a fact that has long been recognized. And if several variables, each of which is a potentially relevant variable, are simultaneously present, the experimenter cannot possibly say which has affected his dependent variable, nor to what degree.

Examination of a list of "independent" variables in child psychology leads one to the conclusions that (*a*) it is often difficult to say which are the dependent and which are the independent variables (e.g., correlations among various tests or other response measures); (*b*) where it is possible to make a distinction, it is often clear that the "independent" variables cannot possibly be either manipulated or isolated from other possibly relevant variables (e.g., chronological age, level of parent education, racial or nationality background, intelligence, socio-economic status, etc.); and (*c*) in many cases, the so-called independent variables were never meant to be anything more than a name for a whole host of potentially relevant variables (e.g., chronological age, sex, school grade, delinquency, etc.). It was undoubtedly in reaction to the selection of such independent variables that Lewin made his persistent pleas for the study of genotypic rather than phenotypic variables in child behavior. For Lewin, genotypic variables were worthy candidates for inclusion in the axioms of theory; phenotypic variables were those that had to be accounted for in terms of the theory.

Another useful consideration in the construction of a theory arises from the recognition that somewhere among the axioms of the theory there must

be some that instruct the scientist about the analysis of more complex phenomena than he has yet encountered experimentally. The scope of a theory—that is, the number and variety of phenomena that it can explain —is closely dependent on the existence of these composition laws among its axioms. Some of the best, and simplest, examples of such laws in psychology can be found in current conditioning theories of learning, where there are laws that specify how conditioning principles can be made to apply in situations in which conditioning and extinction occur at the same time, in which two or more stimuli conditioned to the same response are presented simultaneously, in which two or more stimuli evoking incompatible responses are given together, and so on. Such laws are almost always discovered through series of experiments designed to discover the limits of previous generalizations and to isolate the conditions under which previous generalizations actually hold.

It is indeed rare that one finds empirical laws in child psychology that show any promise of successful use as composition laws in the construction of theory. It seems doubtful, for example, that anyone expects the concept of chronological age to be among the basic concepts in any theory of behavior. Rather, we recognize that changes in behavior associated with chronological age are to be explained in terms of amount of previous learning experiences; of physiological and anatomical changes; of changes in the nature of social rewards, punishments, and status; and of other variables that are also more or less incidentally related to time since birth. In spite of this, the research literature reports more relationships of behavior to age than to any other variable except, possibly, intelligence.

It seems to the writers that the fundamental need of child psychology—the development of promising theories—has been greatly handicapped by child psychologists' tendencies to avoid experimental research. In stating this, there is no implication that laws discovered in nonexperimental research are useless; no responsible scientist scoffs at well-established laws. Rather, the objection is to the imbalance. Child psychologists may well look to general psychology for an object lesson. As limited as the theories in general psychology are, compared to what they will undoubtedly be some day, it is not difficult to see the tremendous strides that the field has made in theory construction during the last 25 years. Examination of the empirical bases of these theories shows that they have been obtained from experimentation in which relevant variables have been isolated and controlled.

The writers were trained and have worked as child psychologists, and believe they understand the factors that have led child psychologists away from experimental research. Carefully planned research requires time—time which many child psychologists do not have because the tendency of their employers is to require heavy teaching and service loads of them. Experimental research worthy of publication often requires numerous unpublishable preliminary experiments, which require still more time. On the other

hand, it has been the experience of the writers that it is a relatively simple matter for an ordinary insightful research worker to take several tests, administer them to a group of subjects, obtain the intercorrelations, and produce some correlation coefficients that are statistically significant. In this same connection, it is usually easier to arrange with school administrators to obtain subjects for two or three hours of time from total classes than it is to arrange to have the subjects on an individual basis for a half-an-hour or so, even more so when a frequently illusory appearance of immediate application of results exists.

Another important factor is precedent. We have in mind not only a social or professional reluctance to stray from a trodden path, but also the additional work that is required to do so. Only a few fruitful experimental apparatus and procedures have been worked out for use with children and many of these have been used so rarely that little useful normative information is available. Thus, the child psychologist who is inclined to be experimental must first invent appropriate apparatus and develop workable procedures and instructions. A similar difficulty arises when the potential experimenter attempts to select a problem to investigate. Few of the textbooks and articles in child psychology can be said to be rich sources for experimental hypotheses. On the contrary, most of them are preoccupied with the application of available knowledge. The problems that suggest themselves to the research worker tend to be concerned with immediate, practical situations. This tendency is reinforced by the nature of the duties of the typical child psychologist. He has usually been hired primarily to teach and to perform service. The types of problems that lend themselves to experimental investigation, under such employment and service exigencies, do not seem "big" enough to him, i.e., he can see no immediate prospect of their helping practically to serve society.

All the reasons for our failure to have produced a wealth of experimental research, unfortunately, are not as socially acceptable as those just mentioned. The fact is that child psychologists as a group, not unlike clinical psychologists as a group, have not been trained to do experimental research. The literature testifies to our naivete with respect to statistical techniques, the philosophy of science, research methods, and understanding of theory construction. Our statistical analyses are often outmoded and otherwise inadequate; our reasoning is sometimes confused and our concepts are often vaguely defined; our control groups are all too frequently poorly conceived; our notions of what constitutes scientific theory are most unsophisticated.

In order to improve our scientific status, there are several concrete steps that we may take. First, we should stop marking time, waiting for a brilliant theorist to appear who will organize our data into a satisfactory theory. Only a mind sufficiently clairvoyant to intuit the missing basic laws could possibly integrate the data we have available. Second, we can well

look to the relatively more sophisticated field of general psychology for suggestions concerning apparatus, procedures, and hypotheses. There are many techniques that have been used successfully with adults and infrahuman organisms that can be relatively easily modified for use with younger children. It is the writers' belief, too, that current theories in general psychology are replete with hypotheses for the test of which children are not only satisfactory subjects, but *ideal* subjects. Those of us who have dealt with both children and adults know, for example, that the purpose of an experiment is more easily disguised from children than from college sophomores; that learning problems for children can be much simpler (and perhaps the laws discovered more basic) than corresponding problems for adults; that the learning and functions of language can be more fruitfully studied with children than with adults; that children are the ideal subjects for the study of imitation learning; that children can be more easily excited, frustrated, and angered in an experimental situation than can adults; and so on. Several recent experiments with children as subjects have been among the most widely quoted in psychological literature. It is not to the credit of our profession that many of these have been conducted by persons not formally trained in child psychology.

Third, while some of us can, and should, deliberately shirk our applied, clinical responsibilities, there is probably little that most of us can do about the applied and teaching demands that our positions place upon our time. But those of us who are in a position to do so can spend some of our energies in placing well-trained students in positions that both require and allow time for research. Evidence indicates that there is a supply of relatively well-paid positions of this type at the present time. Furthermore, there is likely to be an increase in the number of such positions, since many institutions have become aware that they are not producing psychological research with children and that a fruitful research field may be opened up if they can find properly trained personnel.

Fourth, the availability of good research positions will not help our field if we do not have properly trained personnel to fill them. While there are limits to the extent to which those of us who are several years out of graduate school can improve our personal research competence, there is much that we can do for our students. We can provide them with graduate curricula that include adequate training in statistics, considerable work in the philosophy of science, and thorough familiarity with current theories and with both current and past research in general psychology.

The writers also think that there are more economical ways of achieving familiarity with the conventional content of child psychology and development than have been employed by training centers traditionally. Lectures can be pointed toward organizing and evaluating, rather than endlessly summarizing factual material. Theoretical hunches and fractional ordering concepts about the material can serve as both an interesting and an integrat-

ing framework for students, who can then read what portion of the vast accumulation of normative and developmental material they or their instructors believe to be essential. From such an instructional approach, research ideas may even germinate. The writers suspect that less emphasis on applied duties may profitably (or at least without harm) be given to graduates in training, and that instead of being drilled and practicumed for every imaginable future professional contingency, they may be trained to *think* and to react flexibly and adaptively instead of as well drilled automatons. We feel it is vital to the field that we instill in our students the *fundamental* importance of doing experimental research with children.

Given properly trained personnel who conduct sound experimental research on problems oriented toward theory construction, our contemporary concern for the deficiency in theoretical integration within our field can be constructively put to use and eventually allayed.

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